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A Clinical Study on Surgical Outcome of Acoustic Neuroma in Relation to Tumour Size and Facial Nerve Involvement Using House Brackmann Grading

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Abstract: ***Aim: To evaluate surgical outcome of acoustic neuroma in relation to tumour size and facial nerve involvement using House Brackmann Grading. Material and Method: The present prospective study was conducted at Department of Neurosurgery, Nilratan Sircar Medical College & Hospital, Kolkata among 30 consecutive patients admitted with unilateral Acoustic Schwannoma from May 2019 to November 2020. The surgical management was done in two stages;-in first stage the patients were subjected to venticulo-peritonial shunting to relieve the raised intra cranial pressure (ICP) and in second stage the excision of tumor was done through Retrosigmoid approach. After the management of post operative period the patient was discharged with advice for regular follow up in outpatient department. Post-operative outcome of facial nerve function was assessed by House Brackmann Scale. Results: 23.33%, 50% and 26.67% of the subjects were having tumour size of <2cm, 2-4cm and >4cm respectively. The gross total resection was done in 83.33% (n=25) cases and subtotal done in 16.67% (n=5) cases.6 months after surgery, facial nerve function of grade I-II, III-IV and V-VI was present in 18 (62.07%), 4 (13.79%) and 7 (24.14%) subjects respectively. All the cases in were having I-II HB grade. Mortality was reported in 1 (12.5%) subjects from group 3. Conclusion: The retromastoid approach can be utilized in excision of small, medium and large size acoustic schwanoma and prior to undertaking a complete excision a Ventriculo-peritoneal shunting can be done on emergency basis to counteract the raised intracranial pressure. Leading to good neurological outcome.***

Keywords: Acoustic Schwannoma, Facial nerve, House Brackmann scale

1.Introduction

Acoustic neuroma, also known as vestibular schwannoma, is a benign tumor arising from Schwann cells, which comprise the myelin sheath of the vestibulocochlear nerve (CN VIII) [1]. Incidence of these tumors is approximately one per 100, 000 person-years, a rate that has increased over time[2]. The Acoustic neuroma is the most common tumors of the cerebellopontine angle (CPA) (80–90%) followed by Meningioma (5–10%), Ectodermal inclusion tumours (5–7%). Other tumors of the CPA include primary cholesteatoma, and other cranial nerve schwannoma (V, VII, IX, X), arachnoid cysts etc. These tumors may be asymptomatic or may present with a constellation of symptoms which could be due to tumor mass and involvement of the adjacent cranial nerves, cerebellum and brainstem[3].

The etiology of acoustic neuroma is unknown. Cushing (1917) and Revilla (1948) believed trauma was a plausible explanation, as some observations apparently associated occipital trauma with tumors of the cerebellopontine angle.4 Knowledge of the embryonic development of CN VIII constitutes the foundation of pathogenetic studies that have, on the one hand, provided an understanding of the underlying mechanisms of formation of these nerve tumors and, on the other, shown why of all the cranial nerves, the eighth pair is affected. The most widely accepted hypothesis is the embryonic theory of opposing distal and peripheral fibers that meet at the level of the internal auditory canal to give rise to the vestibulocochlear nerve[5].

It is difficult to identify the meager facial nerve and cochlear nerve clearly and preserve their function during operation because of tumor compression and its abundant blood supply. Moreover, surgical operation would affect the function of cerebellum and brainstem during treatment because of giant tumor, which lead to many complications after surgery.6, [7] Thus, it is still a great challenge for the neurosurgeons to remove tumors totally, preserve neural function, reduce the complications of patients and improve long-term survival quality of life.

The advances and improvements in microsurgical techniques have changed the actual goals of surgery, being facial nerve preservation an utmost concern. Paralysis of the facial expression muscles is a debilitating and psychologically devastating condition for the patient. Preservation of facial nerve function after VS surgery is one of the most important goals to be achieved.8[-10]

This shift was made possible by improved surgical and imaging techniques and the growing experience of neurological and neurosurgical teams. Despite these technical improvements, the percentage of patients with impaired facial function (i. e. House-Brackmann grade III or more) ranges from 7 to 41%[11].

There is no established method that allows precise prediction of the long-term prognosis of facial nerve palsy after VS surgery. It has been suggested that tumor size is an approximate guide to predicting ultimate functional outcome[12]. In our study we correlated the preoperative tumour size of acoustic neuroma with post-operative facial nerve dysfunction by House Brackmann Facial Nerve Grading System.

2.Material and Method

The present prospective, observational study was conducted at Department of Neurosurgery, Nilratan Sircar Medical College & Hospital, Kolkata among 30 consecutive patients admitted with unilateral Acoustic Schwannoma from May 2019 to November 2020. The study population comprised of patients of both sex and age group 30-60 yr. The subjects were included according to the following inclusion and exclusion criteria:

Inclusion Criteria: Patients clinically and radiologically diagnosed with unilateral acoustic schwannoma and to be operated for definitive treatment by suboccipital retrosigmoid approach were included in this study.

Exclusion Criteria: Patients with Recurrent acoustic schwannoma, Neurofibromatosis 2 and bilateral tumours.

Surgery: The surgical management was done in two stages;-in first stage the patients were subjected to venticulo-peritonial shunting to relieve the raised intra cranial pressure (ICP) and in second stage the excision of tumor was done through Retrosigmoid approach. After the management of post operative period the patient was discharged with advice for regular follow up in outpatient department.

Post-operative outcome of facial nerve function was assessed by HOUSE BRACKMANN SCALE (table 1).

Type of dysfunction	Description
I. Normal	Normal facial function in all areas.
II. Mild dysfunction	Slight weakness noticeable on close inspection. No synkinesis, contracture, or hemifacial spasm. Normal symmetry and tone at rest. Moderate to good forehead function. Complete eye closure with minimal effort. Slight asymmetry of mouth.
III. Moderate dysfunction	Obvious, but not disfiguring difference between the sides. Noticeable, but not severe, synkinesis, contracture, or hemifacial spasm. Normal symmetry and tone at rest. Slight to moderate movement of forehead. Complete but asymmetric eye closure with effort. Slightly weak mouth movements with maximum effort.
IV. Moderately severe dysfunction	Obvious weakness or disfiguring asymmetry. Normal symmetry and tone at rest. No forehead movement. Incomplete eye closure. Asymmetry of mouth with maximum effort.
V. Severe dysfunction	Only barely perceptible motion. Asymmetry at rest. No forehead movement. Incomplete eye closure with only slight movement of lid with maximal effort. Slight movement of corner of mouth.
VI. Total paralysis	No movement.

Table 1: House Brackmann Scale

Study Tool:

a. Neurological exam with tuning fork, cotton wisps, pin prick, hot-cold objects, Knee hammer, measuring tape, tongue depressor, swab stick
b. Imaging: MRI Brain (plain and contrast)
c. Intraoperative instruments and operating microscope

Data was collected in a proforma and subjected to statistical analysis.

Statistical analysis: Data so collected was tabulated in an excel sheet, under the guidance of statistician. The means and standard deviations of the measurements per group were used for statistical analysis (SPSS 22.00 for windows; SPSS inc, Chicago, USA). Difference between two groups was determined using chi square test and the level of significance was set at $p < 0.05$.

3.Results

Out of 30 subjects, 22 (73.33%) were females and 8 (26.67%) were males. Hence there was female dominancy in our study. Mean age among the study subjects was 41.06±12.98 years. Maximum subjects were from the age group of 31-40 years (33.33%). Subjects were distributed into three groups based on size of tumour i. e. group 1, 2 and 3. Subjects with tumour size <2cm, 2-4cm and >4cm were grouped into group 1, 2 and 3 respectively.23.33%, 50% and 26.67% of the subjects were having tumour size of <2cm, 2-4cm and >4cm respectively (table 1).

Table 1: Characteristics of the study subjects

Variables	N	%
Gender		
Male	8	26.67
Female	22	73.33
Age Group (in years)		
21-30	8	26.67
31-40	10	33.33
41-50	7	23.33
51-60	4	13.33
>60	1	3.33
Size of Tumour (in cm)		
Group 1 (< 2 cm)	7	23.33
Group 2 (2-4 cm)	15	50
Group 3 (>4 cm)	8	26.67
Total	30	100

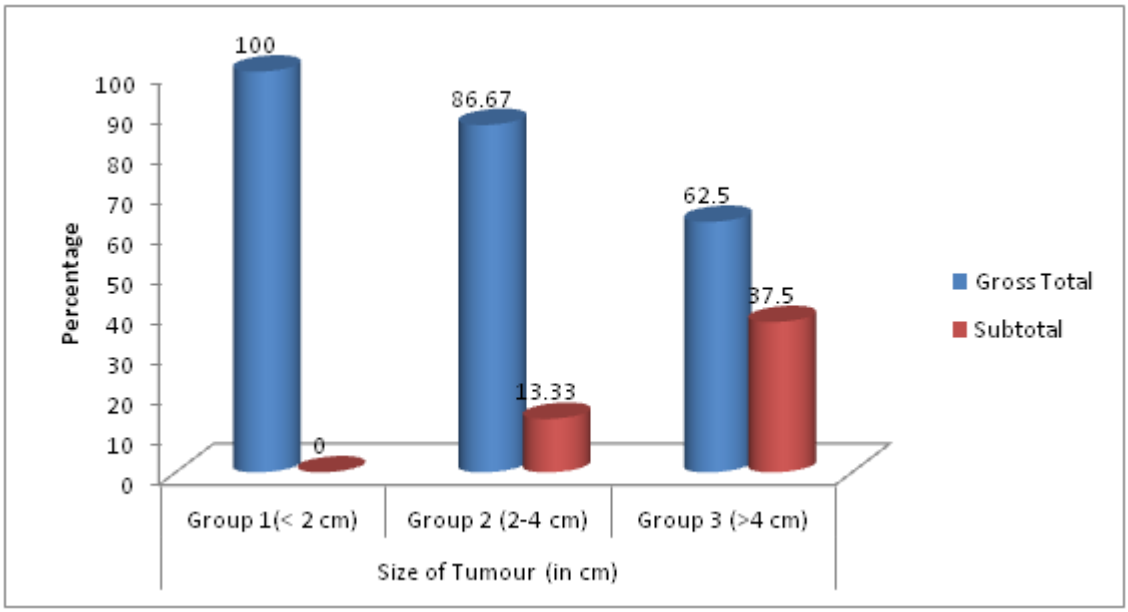
Table 2 shows the preoperative signs and symptoms in patients according to tumor size.7, 6 and 6 subjects having tumor size <2cm were having symptoms viz. sensorineural hearing loss (SNHL), tinnitus and papilloedema. Approximately all the subjects with tumor size of >4cm were having SNHL, tinnitus, papilloedema, vestibular symptoms, facial paresis, trigeminal paresis, lower cranial nerves and cerbellar signs.

Table 2: Preoperative signs and symptoms in patients according to tumor size

Size of tumor	SNHL	Tinnitus	Papilloedema	Vestibular symptoms	Facial paresis	Trigeminal paresis	Lower cranial nerves	Cerbellar signs
< 2 cm	7	6	6	0	0	0	0	0
2-3.9 cm	14	15	14	9	13	7	4	10
>4 cm	8	8	8	8	8	7	6	6
Chi Square	9.17							
p value	0.03*							

*: statistically significant

The gross total resection (graph 1) was done in 83.33% (n=25) cases and subtotal done in 16.67% (n=5) cases. In Group 1 the gross total removal of tumor was done in all the 7 patients. In group 2, subtotal resection was done in 2 (13.33%) patients and gross total resection was done in 13 (86.67%) patients. In group 3, subtotal resection was done in 3 (37.5%) patients and gross total resection was done in 5 (62.5%) patients.



Graph 1: Resection of tumor according to tumor size

Preoperative HB scale I-11, III-IV and V-VI was reported among 90%, 6.67% and 3.33% of the subjects respectively.3 weeks after surgery, facial nerve function of grade I-II, III-IV and V-VI was present in 5 (17.24%), 10 (34.48%) and 14 (48.28%) subjects respectively. Out of 7 cases of group 1; 42.86%, 42.86% and 14.28% of the subjects were having I-II, III-IV and V-VI HB grade respectively. Out of 15 cases of group 2; 13.33%, 40% and 46.67% of the subjects were having I-II, III-IV and V-VI HB grade respectively. Out of 7 cases of group 3 (one expired); 14.29% and 85.71% of the subjects were having III-IV and V-VI HB grade respectively. When tumour size was compared according to HB scale, it was found to be statistically significant as p<0.05.6 weeks after surgery, facial nerve function of grade I-II, III-IV and V-VI was present in 9 (31.03%), 9 (31.03%) and 11 (37.93%) subjects respectively.3 months after surgery, facial nerve function of grade I-II, III-IV and V-VI was present in 14 (48.28%), 7 (24.14%) and 8 (27.59%) subjects respectively.6 months after surgery, facial nerve function of grade I-II, III-IV and V-VI was present in 18 (62.07%), 4 (13.79%) and 7 (24.14%) subjects respectively. All the cases in were having I-II HB grade. Out of 15 cases of group 2; 66.67%, 20% and 13.33% of the subjects were having I-II, III-IV and V-VI HB grade respectively. Out of 7 cases of group 3 (one expired); 14.29%, 14.29% and 71.43% of the subjects were having I-II, III-IV and V-VI HB grade respectively. When tumour size was compared according to HB scale, it was found to be statistically significant as p<0.05 (table 3).

Table 3: Post-operative House-Brackmann Scale according to tumor size at 3 weeks, 6 weeks, 3 months and 6 months

3 Weeks	HB Scale					
	I-II		III-IV		V-VI	
	N	%	N	%	N	%
Group 1 (< 2 cm)	3	42.86	3	42.86	1	14.28
Group 2 (2-4 cm)	2	13.33	6	40	7	46.67
Group 3 (>4 cm)	0	0	1	14.29	6	85.71
Chi Square	13.08					
p value	0.008*					
6 Weeks						

Group 1 (< 2 cm)	5	71.43	2	28.57	0	0
Group 2 (2-4 cm)	4	26.67	6	40	5	33.33
Group 3 (>4 cm)	0	0	1	14.29	6	85.71
Chi Square	9.77					
p value	0.02*					
3 Months						
Group 1 (< 2 cm)	6	85.71	1	14.29	0	0
Group 2 (2-4 cm)	7	46.67	5	33.33	3	20
Group 3 (>4 cm)	1	14.29	1	14.29	5	71.43
Chi Square	10.97					
p value	0.009*					
6 Months						
Group 1 (< 2 cm)	7	100	0	0	0	0
Group 2 (2-4 cm)	10	66.67	3	20	2	13.33
Group 3 (>4 cm)	1	14.29	1	14.29	5	71.43
Chi Square	11.71					
p value	0.005*					

*: statistically significant

None of the patient in group 1 suffered from any complication. Mortality was reported in 1 (12.5%) subjects from group 3. CSF leakage and lower cranial nerves involvement was found among 20%, 26.67% and 25%, 100% of the subjects in group 2 and 3 respectively (table 4).

Table 4: Complications according to tumor size (excluding facial involvement)

Size of Tumour (in cm)	CSF leakage		Lower cranial nerves involvement		Mortality	
	N	%	N	%	N	%
Group 1 (< 2 cm)	0	0	0	0	0	0
Group 2 (2-4 cm)	3	20	4	26.67	0	0
Group 3 (>4 cm)	2	25	8	100	1	12.5

4.Discussion

Refined microsurgical techniques and advances in intraoperative monitoring of the cranial nerve function have improved surgical results in the elimination of this type of lesion. Mortality has diminished and the preservation of facial and cochlear nerves, with the consequent preservation of hearing, has become a reality. Nonetheless, the surgery of acoustic neuromas is risk-free and the possibility of serious post-surgical complications still exists[13, 14]. Compared to others approaches, it is more beneficial to choose suboccipital retrosigmoid approach for the full exposure of vestibular schwannoma[15]. The present study was conducted to correlate the preoperative tumour size of acoustic neuroma with post-operative facial nerve dysfunction by House Brackmann Facial Nerve Grading System.

30 patients diagnosed with Acoustic Neuroma were included in the study. Out of 30 subjects, 22 (73.33%) were females and 8 (26.67%) were males. Hence there was female dominancy in our study. Similar results were reported by Veronezi et al[16], Ashraf Mohamed Farid et al[17] and Dixit S et al[18] in their study, but in series of Memari F et al[19], there was male predominance.

In this study, mean age among the study subjects was 41.06±12.98 years with maximum subjects from the age group of 31-40 years (33.33%). Memari F et al[19] had mean age of 49 years in their series. In a study by Dixit S et al[18], the maximum number of cases i. e.38.46% (n=5) were of 31 to 40 years of age. Ashraf Mohamed Farid et al[17] in their study revealed similar age distribution too.

In our study; 7 and 6 subjects with tumor size <2cm were having sensorineural hearing loss (SNHL) and papilloedema respectively. Approximately all the subjects with tumor size of >4cm were having SNHL, tinnitus, papilloedema, vestibular symptoms, facial paresis, trigeminal paresis, lower cranial nerves and cerebellar signs. Memari F et al[19] had observed that forty-seven patients (94%) presented with tinnitus, and vertigo was present in 30 patients (60%). Similarly in a study by Dixit S et al[18], the most common symptom was ipsilateral sensorineural hearing loss (SNHL) and tinnitus which was present in all 13 patients (100%).

Pre-operatively, HB scale I-11, III-IV and V-VI was reported among 90%, 6.67% and 3.33% of the subjects respectively.3 weeks after surgery, facial nerve function of grade I-II, III-IV and V-VI was present in 5 (17.24%), 10 (34.48%) and 14 (48.28%) subjects respectively.3 months after surgery, facial nerve function of grade I-II, III-IV and V-VI was present in 14 (48.28%), 7 (24.14%) and 8 (27.59%) subjects respectively.6 months after surgery, facial nerve function of grade I-II, III-IV and V-VI was present in 18 (62.07%), 4 (13.79%) and 7 (24.14%) subjects respectively. All the cases in were having I-II HB grade. Out of 15 cases of group 2; 66.67%, 20% and 13.33% of the subjects were having I-II, III-IV and V-VI HB grade respectively. Out of 7 cases of group 3 (one expired); 14.29%, 14.29% and 71.43% of the subjects were having I-II, III-IV and V-VI HB grade respectively in the present study.

In various published series, facial nerve function is conserved in 65%-98% of patients.[20, 21] Anatomical

preservation does not mean functional normality as, even in centres with a lot of expertise, definitive facial function at degrees I-IV is attained in around 80% of the patients. Optimal functional facial results (degrees I and II) 1 year after the operation depend greatly on the size of the tumour: they are the norm in small tumours, whereas in large tumours they generally do not go above 50%[22].

The functional facial nerve results do not appear to be affected by the approach used; thus, in a series of 17 cases with an average size of 2.5 cm operated with the retrosigmoid approach, 59% of the patients had facial function of House-Brackmann degrees I-II after 1 year, while in 81 cases with an average size of 2.5 cm operated with the translabyrinthine method, 68% reached the same degree of facial function, without significant differences[23].

Merari F et al[19] had reported thirty-two patients (64%) had a Grade 1 or 2 score at 1 year, while 26% had a score of 3 or 4, and 8% had a score of 5 or 6. They also found that there was a significant correlation between tumor size and facial nerve outcome, with larger tumors yielding worse outcomes. Gormley et al[24] showed House-Brackmann evaluation of postoperative facial nerve function revealed excellent results (Grade I or II) in 96% of small tumors, 74% of medium tumors, and 38% of large tumors. A fair postoperative function (Grade III or IV) was achieved in 4% of small tumors, 26% of medium tumors, and 58% of large tumors. Matthies C et al[11] in there series of 1000 cases showed that the facial nerve was anatomically preserved in 929 cases (93%). In 200 cases of tumor resections using the CPA approach, preservation rates rose to 94%, independent of tumor size. Facial nerve function graded according to the House-Brackmann scale within 2 weeks after surgery, was Grade 1 in 47%, Grade 2 in 12%, Grade 3 in 14%, Grade 4 in 6%, Grade 5 in 10%, and Grade 6 in 11% of the patients. Jain VK et al[15] in there series showed facial nerve was anatomically preserved in 79.2% (198/250) patients with complete tumor excision. Our results were approximately similar to the above mentioned studies.

In this study, CSF leakage and lower cranial nerves involvement was found among 20%, 26.67% and 25%, 100% of the subjects in group 2 and 3 respectively. Merari F et al[19] had rates of CSF leakage for retrosigmoid approach around 21%. They found that tumor size and other factors such as delayed wound healing and episodes of increased intracranial pressure were important in CSF leakage. Gormley et al[24] reported cerebrospinal fluid leakage in 15% of the patient. Matthies C et al[11] reported Cerebrospinal fluid leaks developed in 3 patients (6%) 2 were treated with lumbar drainage and 1 needed surgical closure. Jain VK et al[15] in their study found that cerebrospinal fluid (CSF) leak occurred in 4% patients. In a study by Dixit S et al[18], CSF leakage was present in post-operative in 23.07% (n=3) cases.

In our study, none of the patient in group 1 suffered from any complication. Mortality was reported in 1 (12.5%) subjects from group 3. The post-operative mortality rate is between 0.5% and 1.5% and is generally due to post-surgical haemorrhage. Special attention should be paid to achieving perfect haemostasis prior to closure. It is also recommended to extubate the patient once the operation is finished, in order to detect any change in vital signs[25, 26]. Merari F et al[19] had mortality of 2 % for retrosigmoid approach. Gormley et al[58] revealed 1% mortality in there case series. Jain Vk et al[15] have observed mortality was 6% in their series. Sami M et al[7] reported no mortality in their series. In a study by Dixit S et al[18], there was 1 (7.6%) mortality which was due to post-operative respiratory infection.

In our study of patients the short-and long-term facial nerve outcome was good and comparable with those of other series reported in literature in the last years. Complication rates were excellent and no deaths were reported. A good facial function was mostly preserved in patients with small and medium size tumors, while lower results were obtained in case of larger tumors.

The limitations of this study are being having a limited number of patients and the diffusion tensor tractography-fiber tracking of the cranial nerves is costly and not available in our institute. Also facial nerve monitoring too is not available in our institute.

5.Conclusion

Acoustic neuroma size influences the development of both intra and posts operative complications operative morbidity and mortality. There is obvious and significant correlation between tumor size and post-operative facial nerve outcome, CSF leak with larger C. P. A. tumors yield worse outcomes. The retromastoid approach can be utilized in excision of small, medium and large size acoustic schwanoma and prior to undertaking a complete excision a Ventriculo-peritoneal shunting can be done on emergency basis to counteract the raised intracranial pressure. Combination of above two can help in bringing good neurological outcome in patients with CPA tumors.

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