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FASCIAL NERVE PRESERVATION IN CEREBELLOPONTINE ANGLE TUMORS SURGERIES

By

Osama Ali Ahmed Ali, Mohamed Ahmed Ellabbad and El-Sayed Abd El-Rahman Elmor

Department of Neurosurgery, Faculty of Medicine, Al-Azhar University

E-mail: Osamaaliahmedali5@gmail.com

ABSTRACT

Background: Impairment of the facial nerve functions, after cerebellopontine angle surgery is a common complication that limits the quality of life. Appropriate preoperative planning with a visualization of the facial nerve is a vital tool for the proper management of this disease.

Objective: To discuss retrospectively and introspectively, the different modalities helping in preservation the facial nerve during cerebellopontine angle surgeries, and to evaluate the outcome of the usage of these modalities.

Patients and Methods: A total of 30 cases with cerebellopontine angle lesions, who had surgical excision of these lesions, performed by different surgical procedure, with preservation of facial nerve function. They were operated upon in Neurosurgery Department at Al-Azhar University Hospitals and Nasser Institute Hospital, during the period between November 2017 and November 2019.

Results: One patient had a CSF leak that was temporarily, one patient had postoperative hydrocephalus that was treated with external ventricular drain, and one patient had small sized intracranial hemorrhage resolved spontaneously and did not need any intervention. The remaining 27 patients have improvement of symptoms and signs at follow up periods of 3, 6, 12 months.

Conclusion: Preservation of the facial nerve, during cerebellopontine angle surgeries, can be done altogether with total removal of the tumor in one session, by usage of microscopic surgical procedures altogether with intraoperative neurophysiological monitoring. Facial nerve preservation is a safe procedure.

Keywords: Cerebellopontine Angle, Fascial preservation, Intraoperative monitoring, Audiometry, Tumor surgeries.

INTRODUCTION

The cerebellopontine angle (CPA) is an anatomically complex region of the brain. It is the area of lateral cistern containing CSF, arachnoid tissue, facial nerve (CN VII) & vestibulocochlear nerve (CN VIII), lateral recess of the 4th ventricle, and associate vessels *(Grunwald et al., 2011).*

Impairment of facial nerve function is a common complication after cerebellopontine surgery that limits quality of life. Appropriate preoperative planning with a visualization of the facial nerve, is a vital tool for the proper management of this disease. Diffusion tensor imaging (DTI) tractography, creates unprecedented in vivo imaging of the anatomical location of white matter tracts *(Hummel et al., 2016).*

Immediate identification of the facial nerve in the cerebellopontine angle will be possible only in those patients in whom the tumor is relatively small. The tumor originates from some fascicle of the vestibular nerve, so that the continuity of the facial and cochlear nerve may be preserved. The facial nerve in such a case can be traumatized, just in front of the internal auditory canal. Removal of the posterior wall of the internal auditory canal, guarantees total tumor removal and the preservation of the facial nerve *(Samii et al., 2010).*

Preservation of facial nerve injury during resection of VS is a primary aim of the skull base surgeon. Facial paralysis has potentially devastating functional and psychological consequences for patients *(Matthew et al., 2012).*

The importance of intraoperative monitoring especially during resection of vestibular schwannomas comes from the anatomical fact that the facial nerve, from the brainstem to the internal auditory canal, has no epineurium *(Nagasawa et al., 2012).*

The aim of the present work was to discuss retrospectively and anterospectively the different modalities helping in preservation the fascial nerve during cerebellopontine angle surgeries and to evaluate the outcome of the usage of these modalities.

PATIENTS AND METHODS

A retrospective and anterospective study was conducted from November 2017 and November 2019 in Neurosurgery Department at Al-Azhar University Hospitals and Nasser Institute Hospital. An informed signed consent was taken from every patient before enrolling them into the study. A total of 30 patients were enrolled in our study. The inclusion criteria were for all cases of radiologically demonstrated lesions, localized to cerebellopontine angle which would be surgically excised. Patients with a target outside the cerebellopontine angle and cases of extracranial fascial nerve palsy were excluded from the study.

A complete clinical and radiological analysis was performed for all these patients. Clinical evaluation included a detailed history from the patient, regarding the onset of symptoms and complete neurological examination was applied for every case with a special emphasis on the following items which were likely affected in cerebellopontine angle lesions, facial motor movements, ataxia, hearing intensity (Weber and Rinne tests), corneal reflexes and facial sensory examination. CT brain was done as a best modality for imaging and delineating of the bony anatomy to establish the diagnosis and to show the early expansion of the internal auditory meatus. Magnetic Resonance Imaging (MRI) of the brain, with and without contrast was essentially obtained for all cases preoperatively. These MRI images were meticulously reviewed for site, size, extension of the mass or lesion. The size was evaluated by high resolution MR imaging for all cases. MRI in sagittal, axial and coronal images before and after gadolinium diethylenetriamine penta acetic acid intravenously. Immediate postoperative MRI and/or CT brain were done for all cases; to detect the extent of tumor excision and any associated complications.

Constant physiological Intraoperative monitoring equipment was placed. Bipolar facial monitoring electrodes were routinely placed in the orbicularis oculi and orbicularis oris. Detection of muscle action potentials was done by three ways, continuous running facial nerve electromyographic monitoring, direct monopolar or bipolar electrical stimulation of the facial nerve that caused a clearly visible "smile" reaction. Dual monopolar or bipolar electrical stimulation altogether with continuous electromyography monitoring also was used. Clinical and surgical assessment was done using House‑Brackmann scale (H‑B) and Hannover scale for tumor extension.

Statistical analysis:

Recorded data were analyzed using the statistical package for the social sciences, version 22.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean ± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

- Chi-square (x2) test of significance was used in order to compare proportions between qualitative parameters.
- The confidence interval was set to 95% and the margin of error accepted was set to 5%. The p-value was considered significant when $P \leq 0.05$.

RESULTS

During the period of study we operated upon thirty patients, fourteen patients were females (46.67%) and sixteen patients were males (53.33%), P-value = 0.0154. Their ages ranged from 18 years to 69 years with an average age 49, 05, a mean age of 43.17 years with standard deviation (SD) 14.77. High percentage of patients 23.33% (7/30) were in the fourth decade of life, 20 % (6/30) in the fifth decade, 20% (6/30) in the sixth decade, 16.67% (5/30) in the seventh decade, 16.67% (5/30) in the third decade and only 1 patient (3.33%) was in the 2nd decade of life. According to histopathological reports for after postoperative biopsy examination, twenty four patients out of total number of thirty cerebellopontine lesions (24/30→ 80%) were vestibular shwanomas, four cases (4/30→13.33 %), were meningiomas and two cases (2/30→6.67 %), were epidermoids. Different cranial nerves were affected to different degrees, as diagnosed by different symptoms and signs. Chochlear nerve was the most frequent cranial nerve affected (27 / 30→90 %), followed by the vestiblar nerve (13/30→43.33 %), trigeminal nerve (7/30→23.33 %), facial nerve (3/30 →10%) and last cranial nerve affected was abdicant nerve (1/30 →3.33%). Only three patients (3/30→10%) had postoperative complications, one patient had CSF leak that was temporarily and ceased spontaneously after 7 days, other patient had postoperative hydrocephalus that was treated with external ventricular drain and one patient had a small sized intracranial haemorrhage, that appeared with the follow up CT brain and resolved spontaneously. Right sided cerebellopontine angle lesions were 17 cases out of total number of 30 patients (56.67%) while Left sided lesions were 13 cases (43.33%) **(Table 1)**.

Table (1): Demographic and general data of the patients

Data / Parameters	Number	Percentage	Mean ± SD
Sex			
Male	16	53.33 %	
Female	14	46.67 %	
Age			43.17 ± 14.77.
Histopathology			
Vestibular shwanoma	24	80 %	
Meningiomas	4	13.33 %	
Epidermoids	2	6.67 %	
Cranial nerves affected			
Chochlear	27	90%	
Vestibular	13	43.33%	
Trigeminal	7	23.33%	
Fascial	3	10%	
Abducent	1	3.33%	
Complications			
CSF leak	1	3.33%	
Hydrocephalus	1	3.33%	
Minimal ICH	1	3.33%	
Side of the lesion			
Right	17	56.67%	
Left	13	43.33%	

Clinically, the data of patient's symptoms and signs were collected and analyzed. The most common initial symptoms, including tinnitus or hearing loss, followed by vertigo, dizziness, or unstable gait. The time from initial symptoms to tumor diagnosis varied from 2 month to 8 years. Twenty three percent of the patients had trigeminal nerve symptoms and signs at presentation. Fifty seven percent 4/7 (57.14%) of the patients with trigeminal symptoms had hypersthesia or anesthesia in the zone of the trigeminal nerve. Twenty eight percent 2/7 (28.57 %) showed signs of paresthesia. Fourteen percent 1/7(14.29%) presented with trigeminal neuralgia from total of patients, who complained of trigeminal signs and symptom. Only 3 patients were presented with facial paresis. Two of them (66.66 %) of Hous-Brakmann grade 1 and one patient (33.33%) of grade 2. The cochlear nerve was the most frequently affected cranial nerve (90%). Only 10 % of the patients presented with normal hearing. 3/27 (11.11%) has defective hearing and 22/27 (81.5%) had hypacusis. 13/27 (48.15%) of the patients suffered tinnitus. In most patients, a combination of symptoms, vertigo, dizziness, positional dizziness, and gait instability, was observed. Cerebellar signs were apparent in only six patients (20%). Vestibular nerve and cerebellar signs and symptoms including: vestibular disturbance was presented in 14 patients (46.7 %), vertigo was presented in 9 patients (30 %), dizziness in 5 patients (16.7 %), positional vertigo in 2 patients (6.7%), gait instability in 9 patients (30 %) , and Romberg's sign was presented in two patients (6.7%) **(Table 2)**.

Table (2): Signs and symptoms of cranial nerves and cerebellar compression

Sign or Symptom	Number	Percentage
Vestibular disturbance	14	46.7 %
Vertigo	9	30%
Dizziness	5	16.7%
Positional vertigo	2	6.7%
Gait instability	9	30%
Romberg sign pathological	2	6.7 %
Defective hearing	3	11.11 %
Hypacusis	22	81.5%
Tennitus	13	48.15%

There was an insignificant relationship between the extent of surgical tumor resection and tumor extension Hannover class as when the Hannover class increased, tumor resection decreased , and vice versa Anatomical facial nerve preservation was done in 29 patients (29/30→96.66%). In one patient (1/30 →3.33 %) facial nerve integrity could not be preserved. In tumors with Hannover class T1, T2, T3a and T3b, the rate of anatomical facial nerve preservation was 100 %. The only one patient, in which anatomical preservation could not be possible, had Hannover tumor extension T4 and it was of large sized tumor more adherent and compressing to the surrounding structures **(Table3)**.

Table (3): Relationship between the Extent of tumor resection and Tumor extension Hannover class

Extent of tumor removal / Hannover Class of tumor extension	total tumor removal		Subtotal tumor removal		*Total*		P-Value
	N	**%**	**N**	**%**	**N**	**%**	
T1	**3.00**	**100.00**	**0.00**	**0.00**	**3.00**	**10.00%**	
T2	**2.00**	**100.00**	**0.00**	**0.00**	**2.00**	**6.67**	
T3a	**4.00**	**100.00**	**0.00**	**0.00**	**4.00**	**13.33**	
T3b	**6.00**	**100.00**	**0.00**	**0.00**	**6.00**	**20.00**	**> 0.05**
T4a	**11.00**	**91.67**	**1.00**	**8.33**	**12.00**	**40.00**	
T4b	**2.00**	**66.67**	**1.00**	**33.33**	**3.00**	**10.00**	
Total	**28.00**	**93.33%**	**2.00**	**6.67**	**30.00**	**100.00**	

There was a statistically insignificant difference P value as regard of facial nerve function improvement at two weeks, three months and one year follow up periods. Two weeks postoperatively, out of the twenty nine patients for whom facial nerve was anatomically preserved, twenty three patients (23/29→ 79%) had postoperative function ranges from excellent HB I, II grades to good HB grade III. Three months postoperatively, out of the twenty nine patients for whom facial nerve was anatomically preserved, twenty five patients (25/29→ 86.21%) had postoperative function ranges from excellent HB I, II grades to good HB grade III. One year postoperatively, out of the twenty nine patients for whom facial nerve was anatomically preserved, twenty seven patients (27/29→ 93.10%) had postoperative function ranges from excellent HB I, II grades to good HB grade III **(Table 4)**.

Table (4): Percentage and number of patients who had excellent to good facial nerve (All 29 patients had mild scores)

Follow up period	Excellent to good facial nerve physiological preservation		P-Value
	N	%	
Two weeks	23	79.31%	> 0.05
Three months	25	86.21	
1 year	27	93.10	

Patients, who had Intaoperative neurophysiological monitoring, had better outcome than patient who had not this monitoring. In monitored patients, at 1 year postoperative follow up, 22(73.3%) patients had excellent function (House- Brakmann grade I and II), 3 patients (10 %) had good function (House- Brakmann grade III) and only one patient (3.33%) had fair function and no any case had a bad function or paralysis. In non-monitored patients, at 1 year postoperative follow up, 2 (50 %) patients had excellent function (House- Brakmann grade I and II), one patient (25%) had fair function and one case had complete paralysis with an insignificant statistical P value **(Table 5)**.

Table (5): Relationship between intraoperative physiological monitoring and facial nerve function at one year postoperatively follow up using House Brakmann scale

House Brakmann Scale for Facial nerve Function / Monitoring	Grade 1		Grade 2		Grade 3		Grade 4		Grade 5		Grade 5		Total		P-Value
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	
Monitored	15	50	7	23.3	3	10	1	3.3	0	0	0	0	26	86.6	
Non monitored	2	6.67	0	0	1	3.3	0	0	0	0	1	3.3	4	13.3	> 0.05
Total	17	56.7	0	0	4	13.3	0	0	0	0	1	3.3	30	100	

DISCUSSION

In the present study, thirty patients were operated upon, fourteen patients were females (46.7%) and sixteen patients were males (53.3%). Age ranged from 18 to 69 years with an average age 49, 05, mean of 43, 17 years and 14,77 standard deviation. *(Chen et al. 2011)* reported a slight male predominance (51.2%), and female percentage (48.8%) with statistically insignificant.

In our study, according to histopathological reports of biopsy, 80% were vestibular shwanomas, 13.33 %, were meningiomas and 6.67 % were epidermoids. *Weber and Zamani (2010)* stated that Vestibular schwannomas, meningiomas and epidermoids account for a vast majority of the lesions occurring in the cerebellopontine angle (CPA). Neoplastic and non-neoplastic pathologies other than these tumors constitute 1% of all lesions located in the CPA. Rare lesions were revealed as a case of craniopharyngioma, a case of chloroma, a case of solitary fibrous tumor, a case of pinealoblastoma, a case of atypical teratoid rhabdoid tumor, a case of an aneurysm, a case of hemorrhage and a case of abscess.

In the present study, the most common initial symptoms included tinnitus and hearing loss, followed by vertigo, dizziness, and unstable gait. The time elapsed from initial symptoms up to tumor diagnosis varied from 2 month to 8 years. 57.14% of the patients with trigeminal symptoms had hyposthesia or anesthesia in the zone of the trigeminal nerve. 28.57 % showed signs of paresthesia. 14.29 % presented with trigeminal neuralgia from total of patients who complained of trigeminal signs and symptoms. 66.66 % of Hous-Brakmann was of grade 1 33.33 % was of grade 2.The cochlear nerve was the most frequently affected cranial nerve 90 %. Only 10 % of the patients presented with normal hearing. 11.11 % had defective hearing and 81.5% had hypacusis. 48.14% of the patients suffered tinnitus. In most patients, a combination of symptoms—vertigo, dizziness, positional dizziness, and gait instability—was observed. Cerebellar signs were apparent in 20% of patients .vestibular disturbance was presented in 46.7 %, vertigo was presented in 30 % and dizziness in 16.6 %, positional vertigo in 6.7%, Gait instability in 30 %, and Romberge sign was presented in 6.7%. *Samii et al. (2010)* reported that, further impaired vestibular function, cerebellar and brainstem compression lead to gait instability and long tract signs in 30–50% of patients. *Zhang et al. (2017)* reported in his study that, hearing loss was the most presenting symptoms, followed by tinnitus, dizziness and signs of increased intracranial tension.

In the present study, there was a relationship between the extent of surgical tumor resection and tumor extension, as Hannover class increased → tumor resection decreased and vice versa. Van *Gompel et al. (2018)* mentioned that the tumor maximum diameter and extension degree were the most important factors determining the extent of tumor resection.

In the present study, anatomical facial nerve preservation was in 96.66%, In 3.33 % facial nerve integrity could not be preserved. In tumors with Hannover class T1, T2, T3a and T3b, the rate of anatomical facial nerve preservation was

100 %. The only one patient in which anatomical preservation could not be possible had Hannover tumor extension T4 and it was of large sized tumor more adherent and compressing to the surrounding structures. There was a statistically difference in surgical outcome as regard of anatomical facial preservation in relation to tumor extension class. *Hadjipanayis et al. (2018)* found in his study that the anatomical fascial nerve preservation was possible in 124 (96%) .Rate of fascial nerve preservation was 98% in timor class T1-T3. Integrity of fascial nerve could not preserve in two patients with T4 class meningiomas.

In the present study, there was a statistically significant difference. There was facial nerve function improvement at two weeks, three months and one year follow up periods. Two weeks postoperatively, out of the patients for whom facial nerve was anatomically preserved, 79% had postoperative function ranges from excellent HB I, II grades to good HB grade III. Three months postoperatively, 86.21% had postoperative function ranges from excellent HB I, II grades to good HB grade III. One year postoperatively, 93.10% had postoperative function ranges from excellent HB I, II grades to good HB grade III. *Kulwin et al. (2012)* documented good postoperative function Grade I, Grade II, III at end of 3 months follow up and very good function grade I, II at end of the first year.

In the present study, there was facial nerve preservation 97.3 % in smaller tumors with extension Classes T1 to T3. In cases of larger tumor T4 class, good function was achieved in only 67.6 %. This was quietly accord previous literature and it differ in the aspect of, the only one patient who had complete paralysis, had not improved at the end of the first year follow up. *Gurgel et al. (2012)* made his study that showed facial nerve preservation was 100% in smaller tumors with extension Classes T1 to T3. The rate of excellent or good facial nerve function by the last follow-up examination was 81%. In cases of larger tumor T4 class, good function was achieved in only 38 to 58%.All patients with a complete palsy, immediately after surgery showed improvement after at least 1 year postoperatively.

In the present study, in monitored patients at 1 year postoperative follow up. 73.3% patients had excellent function (House- Brakmann grade I and II), 3 patients (10 %) had good function (House-Brakmann grade III) and only 3.33% had fair function, but no any case had bad function or paralysis. In non-monitored patients, at 1 year postoperative follow up. 6.67 % patients had excellent function (House- Brakmann grade I and II), 3.33% had fair function and one case had complete paralysis. *Sun et al. (2012)* showed that usage of direct and/or continuous running stimulation during vestibular schwannoma was associated with 92% of patients with better HB grades directly after surgery.

In the present study, only 10% had postoperative complications, one patient had CSF leak that was temporarily and ceased spontaneously after 7 days, other patient had postoperative hydrocephalus that was treated with external ventricular drain and one patient had a small sized intracranial haemorrhage with follow up

CT brain that resolved spontaneously. *Angeli et al. (2011)* experienced short-term postoperative non-neurological complications including hematoma in 1.2%, meningitis in 7.6%, CSF leak in 2.7%.The cranial nerve complication included lower cranial nerve deficit in 7.5%.The systemic complications included keratitis in 1.2%, labial herpes in 6.4%, occipital scalp hydrops in 0.5% and pneumonia in 6.2%. *Ansari et al. (2012)* showed long-term complications in form of, facial numbness in 15.7%, chronic headache in 3.18% and taste disturbance in 1.94%, scar pain in 1.77% and decreased vision in 1.23%, delayed hydrocephalus in 1.06%.

CONCLUSION

Preservation of the facial nerve during cerebellopontine angle surgeries, can be done altogether with total removal of the tumor in one session, by usage of microscopic surgical procedures altogether with intraoperative neurophysiological monitoring. Facial nerve preservation is a safe procedure, which should do for all patients when possible. Accurate diagnosis and selection of the suitable surgical approach or procedure were the key points to increase success. Functional preservation of the facial nerve postoperatively, requires preoperative prediction of the location of the nerve, in relation to the capsule, extra-arachnoidal dissection during surgery, and subtotal resection if the intraoperative neurophysiological monitoring predicts a high risk.

RECOMMENDATIONS

We recommend to use Intraoperative neurophysiological monitoring during cerebellopontine angle surgeries with use of meticulous microsurgical dissection techniques because this give better outcome than if not used.

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المحافظة على العصب الوجهى (السابع) في جراحات أورام الزاوية المخيخية الجسرية

أسامة علي أحمد علي، محمد أحمد اللباد، السيد عبد الرحمن المر

قسم جراحة المخ والأعصاب، كلية الطب، جامعة الأزهر

خلفية البحث: يعتبر اعتلال وظيفة العصب الوجهي من المضاعفات الشائعة التي تحدث بعد إجراء الجراحة في الزاوية المخيخية الجسرية. ويعتبر التخطيط السليم ما قبل الجراحة مع تصوير ورؤية العصب السابع إحدى الطرق الحيوية لعلاج مثل هذا الاعتلال.

الهدف من البحث: دراسة وتقييم دور الطرق المختلفة في الحفاظ على العصب المخي السابع (الوجهي) أثناء جراحات استئصال الأورام المخيخية الجسرية وتقييم استخدام مثل هذه الطرق.

المرضى وطرق البحث: تشتمل هذه الدراسة على ثلاثين مريضا كانوا يعانون من أورام بالزاوية المخيخية الجسرية، وقد تم إجراء الجراحة لهم بطرق جراحية مختلفة منهم 14 أنثى (46%) و 16 ذكر (54 %) وقد تم إجراء الجراحة لهم بمستشفيات جامعة الازهر ومعهد ناصر في الفترة الزمنية ما بين نوفمبر 2017 ونوفمبر 2019.

نتائج البحث: كان واحدا من هؤلاء المرضى يعاني تسرب مؤقت للسائل الشوكي ومريض آخر عانى من الاستسقاء الدماغي ما بعد الجراحة، وقد تم علاجة بواسطة درنقة بطينية خارجية، ومريض آخر كان يعاني من نزيف مخي محدود الحجم وقد تم علاجه ذاتيا. وقد تحسنت الأعراض والعلامات لباقي المرضى السبعة والعشرين، وتحسنوا في فترات المتابعة الاكلينيكية على فترات ثلاثة وستة وإثني عشر شهرا.

الاستنتاج: المحافظة على العصب الوجهي خلال جراحات الزاوية المخيخية الجسرية من الممكن تحقيقها مع الاستئصال الكامل للورم خلال جراحة واحدة وذلك بواسطة بعض الطرق الجراحية الميكروسكوبية جنبا إلى جنب مع المراقبة الفسيولوجية العصبية داخل الجراحة، والمحافظة على العصب الوجهي.