PRESERVATION DE LA FONCTION DU NERF FACIAL ET QUALITE DE L'EXERESE DANS LA CHIRURGIE DES SCHWANNOMES VESTIBULAIRES LARGE ET GEANT PAR VOIE RETROSIGMOIDIENNE TRANSMEATALE

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RÉSUMÉ : Une série de 151 schwannomes vestibulaires a été opérée dans notre service a été opérée dans notre service durant une période de cinq ans, entre 2011 et 2015. Le grand axe tumoral dans l'APC était de 30 à 60 mm. Tous les patients ont été opérés en position demi-assise, par voie rétrosigmoidienne et sous monitoring peropératoire continu de la fonction du nerf facial. L'exérèse tumorale a été totale dans 125 cas. Le nerf facial a été préservé anatomiquement dans 149 cas. La fonction du nerf facial était stade I et II de H-B dans 121 cas. La qualité de l'exérèse dépend, dans notre étude, d'un seul facteur : le degré de l'adhérence du nerf facial à la tumeur. La préservation de la fonction du nerf facial dépend de 3 facteurs :

- La préservation anatomique du nerf.
- Le seuil de stimulation du nerf en fin d'intervention ; dans notre étude, ce seuil à partir duquel la fonction du nerf facial était altérée en postopératoire est de 0.2mA.
- Le caractère kystique de la tumeur (10 cas) : la fonction du nerf facial était grade V et VI chez 3 patients parmi les 5 où le nerf facial a été préservé anatomiquement.
- L'existence d'un phénomène de « train activity » (42 cas) : un « train activity » supérieure à 20 secondes, constaté dans 37 cas, a été responsable d'une altération de la fonction du nerf facial dans 28 d'entre eux.

***Mots clés** : Schwannome vestibulaire, approche rétrosigmoïde, Nerf facial.*

ABSTRACT We have operated 151 vestibular schwannomas whom the larger part in the CPA was 30-60mm. All patients were operated in the semi sitting position by retrosigmoid approach and continuous preoperative monitoring of the facial nerve. Tumor excision was complete in 125 patients. The facial nerve was anatomically preserved in 149 patients. It's function was H-B stage I and II in 121 patients.

In our study, extent of excision depended on a single factor : the degree of tumor adherence to the facial nerve. The preservation of the nerve function depends on three factors :

- Anatomic preservation of the nerve
- The threshold of stimulation of the facial nerve at the end of the operation : in our study, this threshold that determins the post operative impairment of the nerve function was 0.2mA.
- Cystic aspect of the tumor (10 cases) : nerve function was grade IV and VI in 3 patients out of 5 where the facial nerve was anatomically preserved.
- The existence of the "train activity" phenomenon (42 patients) : a "train activity " superior to 20 seconds, present in 37 cases, was responsible for the impairment of facial nerve function in 28 cases.

Key words : *Vestibular schwannoma, Surgery, Retrosigmoid approach, Facial nerve.*

INTRODUCTION

Acoustic neuroma is a vestibular schwannoma (VS) which develops on the vestibular nerve in the internal auditory canal (IAC) and then in the cerebello-pontine angle (CPA).

The large and giant vestibular schwannomas [3] always pose a problem of the extent excision and of preservation of the facial nerve function despite the development of microsurgery and per-operative monitoring.

In Algeria, vestibular schwannomas represents 5% of all intracranial operated tumors whom 80.5% are large or giant.

The treatment of VS is a subject of discussion since the times of Cushing. They can be operated in only one stage or in two stages in order to achieve total excision with preservation of the facial nerve function and hearing if possible [19]. Some surgeons perform subtotal resection, followed by radiosurgery.

In our series, 151 VSs were operated by retrosigmoid transmeatal approach, in semi-setting position and with continuous per-operative facial nerve monitoring.

MATERIAL AND METHODS

From January 2011 to December 2015, a series of 1511 large and giant vestibular schwannomas were operated in our department.

The mean age was 48,2 years, the youngest patient was 17 years old and the oldest 78 years. There were 98 women and 43 men.

The most common presenting symptom was hearing loss, observed in 41,66% of all our patients at an average of 24 months before diagnosis. Gait instability was observed in 48,6% and tinnitus in 34,72%. Facial sensory loss or neuralgia was noted in 20%, and headache in 44,44%.

Facial nerve signs were pathological (House Brackmann scores II-VI) in 7 cases (4,63%) before surgery. In 4 patients (2,65%) there were swallowing difficulties.

At the time of diagnosis, 50 patients (33,11%) had intracranial hypertension with hydrocephalus (table1).

Clinical presentations	%
Hearing loss	41.66
Gait instability	48.6
Tinnitus	34.72
Facial sensory loss	17
Facial neuralgia	3
Facial nerve palsy	4.63
Swallowing difficulties	2.65
Intracranial hypertension	33.11

Table I : The most common presenting symptom at diagnosis

For the semi sitting position, the preoperative evaluation includes functional cervical spine X-rays to exclude cervical instability and a Trans thoracic echography to eliminate the persistence of the foramen ovale.

High-resolution bony CT scans (slice thickness 1,5 cm) of the petrous bone provide information regarding the position of the labyrinth and the height of the jugular bulb (JB) [7, 21]. The risk of labyrinth opening during drilling of posterior wall of internal auditory canal (IAC), can be calculated preoperatively based on its relationship with the sigmoid-fundus line [21].The JB was considered High on the bony CT scans when the jugular fossa was above the lower border of the IAC [7].

MRI with CISS sequences is useful to evaluate the extension of the tumor to the Fundus [15]. The largest diameter of the tumor was taken excluding its intracanalicular componement.

All patients were operated using the retrosigmoid approach in a semi sitting position. Facial nerve function was monitored by continuous recording of its electromyographic activity, with two recording electrodes placed in the orbicularis oculi and orbicularis oris muscles. A monopolar stimulus was used to assess facial nerve response. During dissection, a facial nerve stimulator was employed to obtain periodic real-time electromyographic recordings.

The extent of tumor excision was initially judged by the surgeon and confirmed by post operative MRI. The degree of resection was classified as total, subtotal and partial [11] :

- Total resection was defined as no evidence of residual tumor
- Subtotal resection was the condition that a small portion of tumor was left due to its firm attachment to the brain stem or facial nerve or when post operative MRI revealed a little contrast-enhancing area (less than 10% of total tumor).
- Partial resection was defined when a large portion of the tumor could not be resected or the residual tumor amounted to 10-40%.

Facial nerve function was assessed using the House-Brackmann grading scale [2]. Facial nerve function was evaluated immediately postoperatively, at the time of discharge, and at two years after surgery.

RESULTS

In our study, tumor size was more than 31 mm, with maximum diameter of 60 mm. Vestibular schwannoma was cystic in 10 cases (6,6%) (Fig.1).

In 2 cases the jugular bulb was Grade 2 (JB and IAC were seen concomitantly in 2 axial CT slices) (Fig.2).

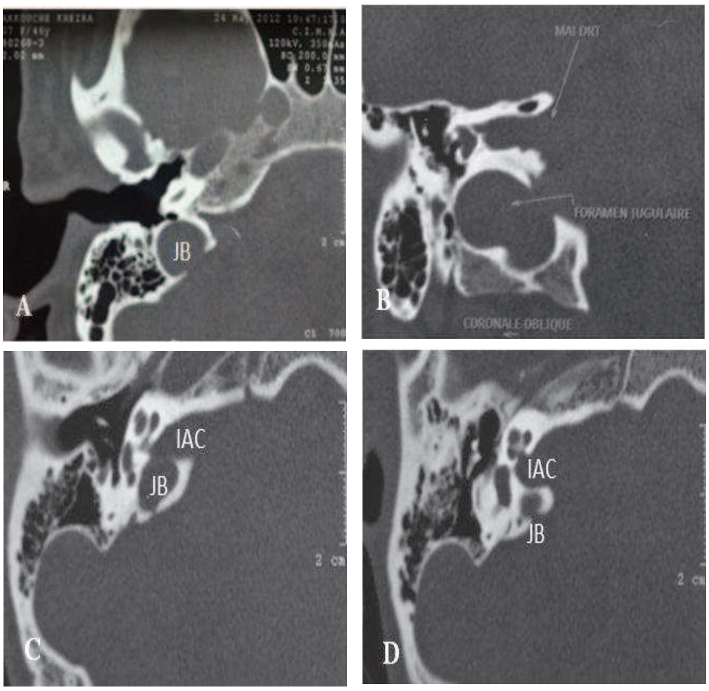

Fig.1: High-resolution bony CT scans of the petrous bone. (a, b) : normal position of jugular bulb, (c, d) : high jugular bulb : JB and IAC were seen concomitantly in 2 axial CT slices. IAC : internal auditory canal ; JB : jugular bulb.

Fig. 2 : a. The semi sitting position. b. skin incision

Surgical technique

Patient was placed in semi sitting position. The Asterion is a good anatomical landmark to identify the projection of "transverse-sigmoid junction" (Fig. 2). The "Digastric point" can also be used as a landmark to expose the posterior margin of sigmoid sinus.

A retrosigmoid craniotomy was performed to expose the inferior margin of transverse sinus, the posterior margin of sigmoid sinus and the floor of posterior fossa (Fig.3). Bone wax is used to pack the mastoid air cells and the emissary vein. In semi sitting position care should be taken with the emissary vein because its maceration posed the risk of air embolism. When a large emissary vein was detected, we preferred to skeletonize the vein and coagulate it under direct view.

After the dura was opened, the cerebellum was retracted with a narrow brain retractor and with a fine bayonet forceps the cerebello-medullary cistern was opened. The drainage of CSF eased the cerebellum retraction.

Among the advantages of the semi setting position is spontaneous drainage of CSF and Blood, which, combined with the constant irrigation with normal saline solution, provides a clean surgical field and enables the surgeon to perform bimanual dissection of the tumor from the surrounding structures. The tumor was removed by internal decompression and later dissection from the cerebellum, cranial nerves, vessels and brainstem.

The monopolar stimulation of facial nerve is used for direct electrical stimulation to localize the nerve prior to tumor resection and intermittently during dissection of the tumor from the nerve. When the tumor was closely adherent to the facial nerve and brainstem a thin layer of tumor capsule was left.

After the tumor resection in the CPA, the dura covering the posterior wall of the internal auditory canal was removed. A high-speed diamond burr was employed to drill the posterior wall of the IAC until the intra-meatal tumor extension was exposed. The length of drilling is determined by the preoperative bone window CT, but usually 5 to 7 mm is sufficient for adequate exposure of the intrameatal tumor (Fig. 4). Once the tumor is identified, debulking is started. Monopolar stimulation is frequently used to identify the facial nerve. A long hook is introduced from medial to lateral to palpate the fundus and to remove the tumor. The facial nerve is usually displaced anterosuperiorly and the cochlear nerve anteroinferiorly.

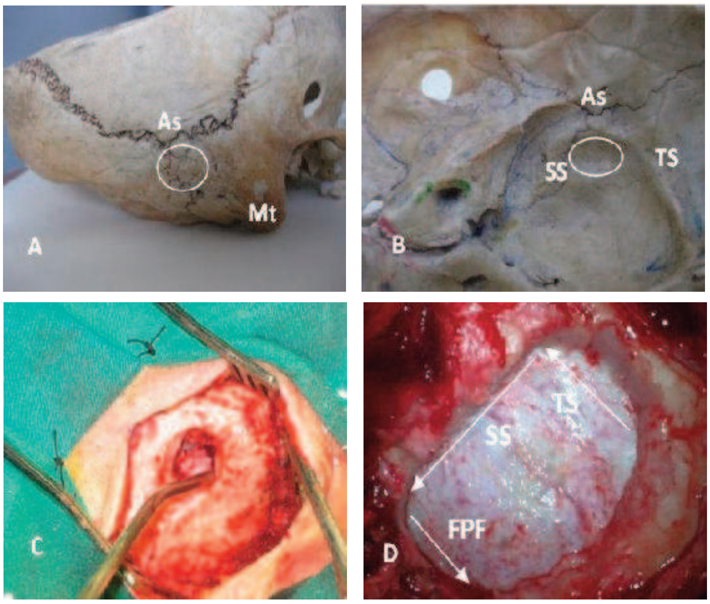

Fig. 3 : The surface landmark to identify the projection of "transverse-sigmoid junction". A retrosigmoid craniotomy was performed to expose the inferior margin of transverse sinus TS, the posterior margin of sigmoid sinus SS and the floor of posterior fossa FPFAs: asterion, Mt: mastoid tip, SS: sigmoid sinus, TS: transverse sinus.

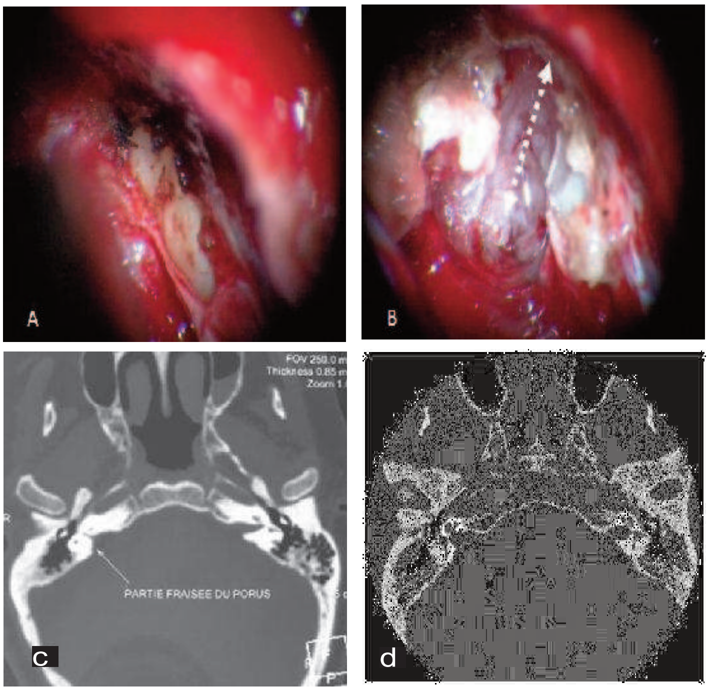

Fig.4: The intrameatal stage: (a) : dura is excised circularly around the posterior lip of the IAC; (b) : the posterior wall of the IAC is drilled. The length of drilling is usually 7 to 8 mm. (c, d): Transmeatal approach in postoperative bony CT-scan.

After resection of the vestibular schwannoma, the monopolar stimulation of facial nerve is used to elicit the stimulation threshold at the brainstem and in IAC.

The lowest stimulation threshold can be elicited by first applying 0,05-mA and increased in 0.05-mA increments until response amplitude is obtained.

Postoperative evaluation was performed in the first week after discharge, at 01 month, and every 03 months after surgery in the first year after surgery.

MRI was obtained 06 months after surgery and annually in the following years. The mean follow up time was 28 months (03-54 months).

MORTALITY AND MORBIDITY:

There were 02 deaths (0,71%) : 01 with postoperative hematoma and 01 with meningitis.

In 04 patients surgery was complicated by postoperative cerebrospinal fluid (CSF) leaks: in 02 cases, the fistula was nasal and was surgically repaired. In the other 02 patients the leakage was local and was treated by lumbar puncture. Four patients had transient swallowing problems in the immediate days after surgery. Six patients had a worsening of balance disorders (table II).

Complications	%
CSF leakage	2
Meningitis	1.32
Intracerebellar hematoma	2.6
Trochlear nerve deficit	0.66
Abducens nerve deficit	1.32
Lower cranialnerve dysfunction	2.6
Cerebellar ataxia	4

Table II: The postoperative complications

EXTENT OF TUMOR RESECTION:

The extent of tumor resection was classified into three groups based on the postoperative MRI performed 3 months after surgery: tumor resection was total in 125 cases (82,8%), subtotal in 21 cases (13,9%) and partial in 05 cases (3,3%) (Table III).

Subtotal and partial resection (Fig. 6) was especially in the case of cystic lesion and achieved in 06 cases among the 8 cystic vestibular schwannomas.

Tumor resection	%
Total resection	82.8 %
Subtotal resection	13.9 %
Partial resection	3.3 %

Table III : The quality of tumor resection

ANATOMICAL AND FUNCTIONAL FACIAL NERVE OUTCOME :

At the end of surgery, the facial nerve was anatomically intact in 149 cases (98,7%). In 02 cases (1,3%) the facial nerve was closely adherent to the tumor and was not preserved (Fig. 5, table 4).

The difficulty of facial nerve preservation increased with irregular contour tumors and cystic tumors.

Facial nerve	%
Anatomically intact	98.7%
Not preserved	1.3%

Table IV: The anatomical integrity of facial nerve at the end of surgery

In the immediate postoperative period 109 of patients (72%) had grade I-II H-B score, 27 (18%) had grade III and IV H-B score and 15 (10%) had grade V and VI H-B score (Table 5).

HB score	Immediate%	24 months%
I	57	61
II	15	21
III	10	07
IV	08	05
V	02	00
VI	08	06

Table V : The postoperative facial nerve function using House-Brackmann grading scale

Generally the facial nerve function improved over the time. The status and the improvement of postoperative facial nerve function depend mainly on 2 factors.

The first factor is the intraoperative stimulus threshold of facial nerve at the brainstem and in IAC after tumor resection and the second factor is the cystic nature of vestibular schwannoma.

In our study the critical stimulation threshold that predicts good long term facial nerve function is 0.1mA.

The functional facial nerve in the case with cystic vestibular schwannoma was poor : 04 patients with V and VI H-B score among the 8 cystic vestibular schwannomas.

Two years after surgery the facial nerve function was (82%) grade I-II H-B scorein 124 cases.

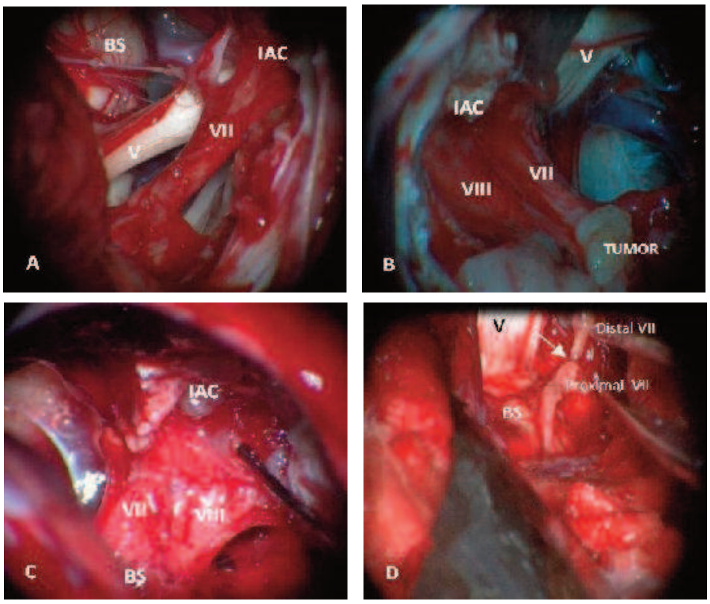

Fig. 5 : (a,b,c) : Anatomic integrity of facial and cochlear nerves. (d) : facial nerve atrophy and its continuity were not preserved. BS : brain stem, V: trigeminal nerve, VII: facial nerve, VIII: cochlear nerve, IAC: internal auditory canal.

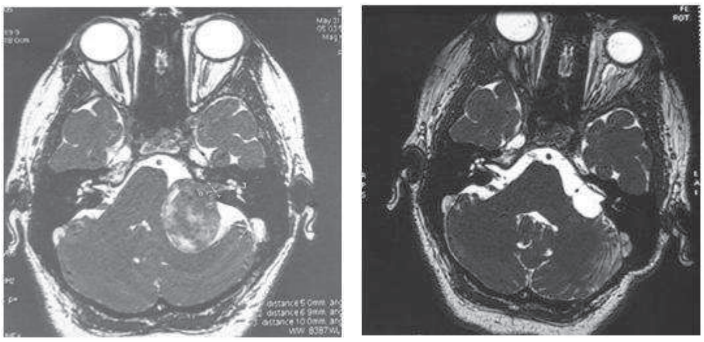

Fig. 6 : Representative cases of geant vestibular schwannoma. (a) : preoperative MRI showed VS measured 49 mm in diameter. (b): postoperative MRI performed 6 months later showed gross total resection.

DISCUSSION

The ideal therapeutic goal in vestibular schwannoma is complete removal of the tumor in a single stage with preservation of anatomical and functional integrity of facial nerve.

Despite advancements in facial nerve monitoring and surgical techniques, functional preservation of the facial nerve in surgery for larger vestibular schwannoma remains a challenge.

According to Gurgel et al. [8] only a few studies referring to the surgical result of facial nerve function in exclusively large vestibular schwannoma patient population have been reported in the literature. A total of 1688 large vestibular schwannomas resected were reported since 1985 to 2011.

The best treatment option in large vestibular schwannoma remains controversial. The proposed strategies include complete removal in 1, 2, or more stages, partial or subtotal removal followed by observation or radiosurgical treatment of the residual part [19].

The first strategy is complete surgical removal and preservation of facial and hearing nerves function. Samii et al. [19] in 50 patients with vestibular schwannoma more than 40mm in maximal extrameatal diameter, total excision was achieved in 97.6%, the anatomical integrity of the facial nerve was preserved in 98,8% and 75% of the patients had excellent or good facial nerve function. Silva et al. [23] in Twenty-nine patients with acoustic neuroma with maximum diameter greater than 40 mm, the anatomic integrity of the facial nerve was preserved in 86% of cases and facial nerve function in 72% of cases. All tumors were completely removed by a retrosigmoid approach, without perioperative mortality.

In the second strategy the surgical procedure was based on the following protocols : Preservation of the intra operative electromyographic response to facial nerve stimulation was considered as the first objective. Anatomical integrity of the facial nerve was regarded as the second priority. Maximum resection of the tumor provided it would not affect the achievement of the two objectives above was performed. In this context Liu et al. [11] operated on 106 large vestibular schwannomas by a retrosigmoid approach. The rate of total resection was 82,1%, the anatomical integrity of facial nerve was achieved in 98,1% of cases and at 2 years after surgery 79,3% of patients had I-II H-B score.

The third strategy is staged resection. In the series of Kartush et al. [4] 34 patients with large vestibular schwannoma were operated in a 2- or 3-staged resection. The first-stage retrosigmoid approach (without meatal drilling) was performed to remove the CPA portion of the tumor and to decompress the brainstem. A second stage translabyrinthine approach was performed at a later date to remove the remaining tumor. A near-total resection was performed in 91% at the last stage of surgery, and 94% of patients had an H-B grade I.

The Fourth strategy is partial resection followed by radiosurgery treatment of the residual part. In this context Pan et al. [12] concluded that planned intracapsular decompression followed by Gamma Knife radiosurgery achieved better preservation of seventh and eighth cranial nerve function.

In our study preservation of the anatomical integrity and intraoperative response to facial nerve stimulation were the essential objective after maximum resection of vestibular schwannoma. In 151 patients with Vestibular schwannoma with maximum diameter between 31mm - 60mm, the total resection was achieved in 82,8% of patients. The facial nerve was anatomically intact in 98,7% and at 2 years after surgery 82% of cases had I-II H-B score. The subtotal or partial resection depended on the extent of facial nerve involvement by the tumor. In our study the facial nerve was adhered closely to the tumor in 41,4% and it was infiltrated or enfolded completely by the tumor in 8,6%.

Since the introduction of intraoperative facial nerve monitoring in 1979 by Prass and Lüders [13, 20], the incidence of facial nerve paresis has significantly reduced in a postoperative physically intact nerve. In our department before introduction of intraoperative facial nerve monitoring the rate of facial nerve paresis was high: 81% in all vestibular schwannomas operated. Since 2010 the use of facial nerve monitoring has become routine, and in 98,7 % of patients with large vestibular schwannomas the anatomical integrity of facial nerve was achieved.

Intraoperative facial nerve monitoring not only helps with identifying the nerve anatomically, but also preserves the functional integrity and helps to predict the postoperative functional outcome of the nerve. Several parameters were studied: The stimulus threshold, the response amplitude and the train activity [20].

Selesnick et al. [22] considered the stimulation threshold of 0,2 mA as the Break point to predicted good postoperative facial nerve function. Neff et al. [10] discovered that stimulation threshold of 0,05 mA or less and a response amplitude of 240μV or more can predict a H-B grade I or II facial nerve function with a 98% probability.

Prell et al. [14] demonstrated a strong correlation between the length of train time and deterioration of post operative facial nerve function. Indeed in addition to intermittent direct electrical stimulation continuous loudspeaker monitoring is applied as a method of "real-time" assessment of the functional integrity of facial nerve. The Train activity is the neurotonic activity in the form of audible prolonged activity reflects functional damage to the nerve. The A train described as a sinusoidal pattern of high frequency and low amplitude signal, was shown to be the most sensitive and specific pattern that can indicate postoperative paresis. Prell et al. [14] found that train time exceeding 10 seconds was correlated with deterioration of post-surgical facial nerve function by two or more grades immediately after surgery.

In our study the A train has been observed in 42 cases (27,8%). We found that 37 patients (88%) patients had a postoperative facial paresis when the train time exceeds 20 seconds.

CONCLUSION

In 151 patients with Vestibular schwannoma with maximum diameter between 31mm – 60 mm, operated by a retrosigmoid transmeatal approach in semi sitting position, the total resection was achieved in 82,8% of patients. The facial nerve was anatomically intact in 98,7% and at 2 years after surgery 82% of cases had I-II H-B score.

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