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Original Article

Eustachian Tube Obliteration and its Effect on Rhinoliquorrhea in Translabyrinthine Vestibular Schwannoma Excision

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OBJECTIVE: Rhinoliquorrhea is defined as a cerebrospinal fluid leakage from the nose. Our objective in this study is to determine the reduction of rhinoliquorrhea rates by Eustachian tube (ET) obliteration in the context of a translabyrinthine approach performed following vestibular schwannoma (VS) excision.

MATERIALS and METHODS: This is a prospective study achieved in a tertiary-care center where the chart review revealed 94 VS operated by the translabyrinthine approach between 2009 and 2015. There were 40 males and 54 females aged from 28-76 years. The only exclusion criterion was a previous history of cranial surgery. ET obliteration was systematically executed when the petrous apex pneumatization level was at least 2 of 4. Our main outcome measure was the development of rhinoliquorrhea.

RESULTS: Eighty-eight patients underwent ET obliteration and were followed for an average of 2.6±1.2 years. Rhinoliquorrhea was reported in 1.14% of the patients having had an ET obliteration. When compared to our previous sample of patients operated with a translabyrinthine approach, it represents a reduction of 84%.

CONCLUSION: Obliteration of the ET is a fast and simple procedure that reduces the rate of rhinoliquorrhea. We therefore recommend its use, specifically in cases of petrous apex pneumatization levels 2-4.

KEYWORDS: Schwannoma, vestibular, acoustic neuroma, CSF fistula, eustachian tube, rhinoliquorrhea

INTRODUCTION

Vestibular schwannoma (VS) is a benign neoplasm that can seriously impair one's quality of life with various manifestations such as vestibular, cochlear, trigeminal, and facial nerve symptoms [1]. In the past years, the greater availability of magnetic resonance imaging (MRI) has led to an increased diagnosis of VS. Its incidence now reaches as much as 0.07% [2], although an incidence of 10-20 million per year is more often reported [3-6]. The advent of the translabyrinthine approach has improved the management of VS [7], despite the fact that some postoperative complications remain considerable.

This is the case of cerebrospinal fluid (CSF) leaks [8-10], the second most common complication of VS resection [10, 11]. Although its incidence is negligible in some studies, it can reach as much as 20% in others, and even more so when considering only large tumors [7, 8, 12]. CSF leaks results from a communication way that takes place between the subarachnoid space, the mastoid air cells, the middle ear, the petrous apex air cells, and finally either the Eustachian tube (ET), the surgical incision, or a tear in the tympanic membrane [7-10, 12-17]. Consequently, the complication can respectively manifest as a rhinoliquorrhea, a wound discharge or an otorrhea [8, 18]. CSF leak is critical, as it prolongs the duration of the hospitalization and increases the risk of meningitis up to 19% [7, 10, 12, 15, 19]. Once objectified by the clinician, it can often be managed conservatively (bed rest, head elevation, pressure dressings) [7, 8, 10, 12, 20] but may also require invasive procedures (lumbar drain, surgical intervention) [21].

Our previous results suggest that such complications can be prevented by altering the surgical wound closure technique when performing the translabyrinthine approach. Systematic obliteration of the ET when the petrous apex pneumatization level was at least 2/4 significantly reduced the incidence of rhinoliquorrhea [22]. The aims of this study are (i) to assess prospectively the reduction of

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CSF leakage rate by obliteration of the ET compared to our previous performance and what is reported in the literature and (ii) to evaluate complications associated with such a technique.

MATERIALS and METHODS

Between January 2009 and December 2015, axial computed tomography was systematically used prior to the excision of VS to determine the level of petrous apex pneumatization. The rationale behind this is that the pneumatization of the petrous apex cells near the genu of the internal carotid canal is a risk factor of CSF leaks through the ET [23-25]. The Saliba petrous apex pneumatization level classification was therefore used to determine whether a patient would undergo ET obliteration [22]. This classification uses the genu of the petrous carotid canal as a main reference, as it lies between the petrous apex and the ET. The pneumatization is absent in level 1, anterior or lateral in level 2, and posterior or medial to the petrous carotid canal in level 3. As for level 4, it signifies that pneumatization is present on at least two sides [22].

Medical charts from all patients operated at our tertiary-care center during this period were analyzed. Demographics, preoperative symptoms, tumor size, postoperative symptoms, and postoperative complications were collected. Pre- or postoperative symptoms investigated include otorrhea, otalgia, ear fullness, tinnitus, ataxia, headaches, and vertigo. Tumor size was determined on preoperative MRI. Complications were defined as facial nerve paresis, hemiplegia, meningitis, subarachnoid or pontine hematoma, cavernous sinus thrombosis, cerebellar edema, and CSF leak. CSF leaks were further investigated considering clinical presentation (rhinoliquorrhea, cutaneous leak, or otorrhea) and management. Confirmation of the leaks by β2-transferrin analysis was obtained for all suspected cases. This study was approved by the hospital ethics committee. All patients gave their written informed consent for the surgical interventions.

Surgical Technique

The surgical techniques are similar to the translabyrinthine approach described in the literature with the addition of systematic obliteration of the ET and the petrous cells around the internal auditory canal (IAC). To allow a better ET exposure, the facial recess is first opened, the incudostapedial and incudomalleolar joints are disarticulated, and the incus is removed. The ET is then completely obliterated under direct microscopic vision by packing musculo-periosteal fragments, bone wax, human fibrin sealant, and oxidized regenerated cellulose (Surgicel). Thereafter, hashed abdominal fat combined with human fibrin sealant is injected into the middle ear cavity, remaining dissected utricle, saccule, and cells of the petrosal apex around the IAC. The incised dura of the posterior fossa and the IAC is then covered by previously retrieved temporal fascia, and the mastoid defect is packed with fat and human fibrin sealant. The incision is subsequently closed in a watertight manner. To prevent serous collection, human fibrin sealant is injected through the incision into the plane between the subcutaneous tissue and the temporal muscle. A large supra-auricular, transcutaneous, and transmuscular 2.0 Vicryl suture is placed to ensure a tight closure between the skin and the temporal muscle. A mastoid dressing is finally done to maintain compression. This surgical technique adds an average of 15 min to the overall operative time. No patient is admitted to the intensive care unit unless there was an intracranial complication.

Statistical Analysis

The associations between the variables were compared using chi-square tests. Pre- and postoperative symptoms were compared using the McNemar test. Statistical significance was determined at $p<0.05$. All statistical calculations were carried out using IBM SPSS Statistics for Windows (Version 22.0. Armonk, NY, USA). Except where otherwise specified, data are expressed as mean ± standard deviation.

RESULTS

Patient Demographics

A total of 109 patient medical charts were retrospectively analyzed. Of these, 94 underwent a translabyrinthine VS excision. Forty males and 54 females were included, aged between 28 and 76 years (mean age, 53.5±7.1 years) and followed-up for 2.1±1.5 years. Eighty-eight patients had an ET obliteration. Complete tumor resection was achieved in 67 patients, whereas 37 had a subtotal resection due to important facial nerve adherence. Four patients had tumor progression (10.8%) (Table 1).

Cerebrospinal Fluid Leaks

Only three cases of CSF leaks were reported. Of these, one was a rhinoliquorrhea and two were cutaneous leaks. The rhinoliquorrhea case and one of the cutaneous leaks were found in people who underwent obliteration of the ET, and both had a postoperative House-Brackmann Grade II. From the six patients classified as level 1 of petrous apex pneumatization (who did not undergo the obliteration of the ET), none had a rhinoliquorrhea but one developed a cutaneous leak and a House-Brackmann Grade I.

Tumor Size Outcome

Tumor size varied from 0.6 to 5.0 cm (mean, 2.41±0.97 cm). VS were classified as either small (≤2 cm), found in 29.5% of patients, or medium/large (>2 cm), found in 70.5% of patients. All three cases of CSF leaks were found in patients with a medium/large tumor.

Facial and Trigeminal Neuropathy

Facial neuropathy was classified according to the House-Brackmann facial nerve grading system [26]. After a mean follow-up of 2 years, 57.6% of the patients had normal facial function in all areas (Grade I), 14.1% showed a slight dysfunction (Grade II), 12.0% experienced

Table 1. Pre and postoperative symptoms

Symptoms	Preoperative (N=94)	Postoperative (N=94)	p
Otorrhea	2.1%	3.2%	1.00
Otalgia	8.5%	3.2%	0.29
Ear fullness	9.6%	5.3%	0.14
Tinnitus	33.3%	20.2%	0.10
Ataxia	4.3%	0%	
Headaches	3.2%	0%	
Vertigo	29.8%	14.9%	0.03
Facial nerve function (2.1±1.5 years)	I: 93.6% II: 3.2% III: 2.1% IV: 0% V: 1.1% VI: 0%	I: 57.6% II: 14.1% III: 12% IV: 7.6% V: 5.4% VI: 3.3%	< 0.001

moderate dysfunction (Grade III), 7.6% had a moderate severe dysfunction (Grade IV), 5.4% had a severe dysfunction (Grade V), and 3.3% were paralyzed (Grade VI). Furthermore, a larger tumor was significantly associated with more postoperative paresthesia and facial paresis (p=0.014 and p=0.024, respectively). Trigeminal neuropathy, as manifested by paresthesia, was reported in 20.2% of the patients after the operation.

Other Complications

One patient developed streptococcal mastoiditis and another developed hydrocephalus. The latter had to be hospitalized in the intensive care unit. There were no cases of meningitis, hemiplegia, subarachnoid or pontine hematoma, cavernous sinus thrombosis, or cerebellar edema.

DISCUSSION

Eustachian Tube Obliteration

Many variations in the technique of translabyrinthine VS surgery have been introduced to improve its outcome [7, 9, 20]. As previously mentioned, CSF rhinorrhea may occur if a communication exists between the middle ear space and the ET. Many have therefore suggested obliterating [8-10, 12, 20, 27, 28] as the most common way of CSF leaks into the nasopharynx, that of the ET.

However, others argue that removing the incus and enlarging the aditus favors CSF leaks into the middle ear [15]. From there, CSF travels through the ET and enters the nasopharynx nulling the initial goal of obliteration. Current literature perpetuates the existing discord, as the efficacy of ET obliteration is inconsistent from one study to another. Whereas some have shown that a meticulous enlarged translabyrinthine approach [8, 9] or a Palva flap technique [10] have the potential to reduce CSF leaks, others report no difference in CSF rhinorrhea rates even though they obliterated the ET [28]. In our previous study, we found a statistically significant decrease in the rate of CSF leaks in patients who had undergone ET obliteration as compared to people who did not [22]. None of the patients who had benefited of an ET obliteration subsequently developed a CSF leak. From the control group, CSF leaks were reported only in individuals who had a pneumatization of level 2 or more. Moreover, as reported in other studies [8-10], we found a correlation between pneumatization level and CSF leaks, and this relationship was independent of tumor size.

The pneumatization of the temporal bone seems to be a strong predictor to whether a patient should undergo ET obliteration. Anatomically, this is explained by the fact that any pneumatized air cell tract facilitates CSF leaks. Such pneumatization might take place either anteriorly in the petrous apex and/or posteriorly in the perilabyrinthine system [9, 10, 17].

In our study, rhinoliquorrhea was reported in 1.14% of the patients having had an ET obliteration. Because of the small number of cases, statistical analyses were not performed. Nonetheless, when compared with our previous sample of patients operated with a translabyrinthine approach, it represents a reduction of 84%. Furthermore, patients from the previous group included individuals with pneumatization levels ranging from one to four, whereas the current sample only contains pneumatization levels equal to or greater than two. These results are consistent with the study conducted by Hardy et al. [29] where a reduction in CSF leak rates from 13% to 1.6% was reported following ET obliteration.

Although it has not been used as a predictive factor, tumor size seems to be associated with a higher risk of developing CSF leaks. In the current study, all three cases of CSF leaks were found in patients with a medium/large tumor. Our previous results also revealed a correlation between the tumor grade and the incidence of CSF leaks. A more extensive study on tumor size as a risk factor for CSF leaks is warranted.

It is important to note that middle ear pressure does not seem to be impaired by ET obliteration. While it might be expected that ET obstruction results in loss of pressure regulation, such a phenomenon has not been objectified in previous studies [22, 30]. Underlying mechanisms may include passive diffusion of gas either through the middle ear mucosa [31, 32] or the tympanic membrane [33], among others.

Other Complications and Postoperative Symptoms

The procedure was generally well tolerated by the patients, and apart from two cases, none developed any major complications. In our previous series, three of the six CSF rhinorrhea cases developed meningitis, whereas no meningitis cases occurred in the present cohort. Facial and trigeminal neuropathies were the most frequent postoperative symptoms reported. Slight dysfunction (Grade II) was the most common level of facial nerve impairment seen.

This study has certain limitations. Although the total number of patients included is large, the small number of patients having had CSF leaks does not allow for thorough statistical analyses. Although it is a prospective study, it still is a single-institution and single-surgeon study. A multicentered prospective study or a meta-analysis may be warranted to strengthen our findings.

CONCLUSION

Through this prospective study on the translabyrinthine approach for VS, we demonstrate the efficacy and positive outcome of ET obliteration. Obliteration of the ET is a well-tolerated and simple procedure that offers a favorable outcome for patients while adding little operative time. We strongly recommend its use in cases of petrous apex pneumatization levels 2-4.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Montreal University Hospital Center (CHUM).

Informed Consent: Verbal informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

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