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Endoscopic assistance in retrosigmoid transmeatal approach to intracanalicular vestibular schwannomas – An alternative for middle fossa approach. Technical note

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ABSTRACT

Background: Complete surgical removal of intracanalicular vestibular schwannomas with nerve VII and VIII sparing and without worsening patient's status is challenging. Also the choice of an optimal surgical technique, which is usually limited to selection between retrosigmoid transmeatal (RT) and middle fossa (MF) approach, can be a challenge. Although many previous studies documented superiority of RT to MF approach and vice versa, still no consensus has been reached regarding an optimal approach to intracanalicular vestibular schwannomas. In this technical note, we present RT approach with an endoscopic assistance and highlight its advantages over MF approach in surgical management of pure intracanalicular vestibular schwannomas.

Method: RT approach with an endoscopic assistance is presented as an optimal surgical treatment for intracanalicular vestibular schwannomas, and its advantages are compared to those offered by MF approach.

Results: Under an endoscopic guidance, we found a residual tumor in the fundus of the inner acoustic canal and performed its gross total resection.

Conclusions: RT approach is an excellent technique suitable for safe radical surgical treatment of T1 vestibular schwannomas; this technique is associated with lower morbidity risk than MF approach.

1. Introduction

Vestibular schwannomas (VSs) are a common pathology, representing ca. 6–8% of all intracranial tumors [1]. Despite recent progress in neuroimaging and resultant increase in the detection rate of pure intracanalicular tumors (T1 according to Hannover classification), their incidence is still no greater than 8% [2,3]. According to Samii and other authors, the decision whether patients with pure intracanalicular VSs should be

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qualified to surgical treatment can be challenging, since most of them present with very good clinical status and normal hearing; also, potential risk for surgical morbidity is an issue [4,5]. Also the choice of an optimal surgical approach, namely selection between retrosigmoid transmeatal (RT) and middle fossa (MF) approach, is a challenge. Although many previous studies documented superiority of RT to MF technique and vice versa, still no consensus has been reached regarding an optimal approach to intracanalicular VSs. Surprisingly, however, there is a growing tendency to use MF approach in this indication [5]. While good visualization of the internal acoustic canal and higher likelihood of hearing preservation are unquestioned benefits of MF approach, this technique may also carry a greater risk of facial nerve injury and temporal lobe damage [2,6,7].

Morbidity of retrosigmoid surgery for acoustic neuromas has been steadily declining since this procedure was first conducted more than a century ago. Although retrosigmoid surgery is currently the most commonly used surgical corridor to VSs, this technique has some limitations in the case of intracanalicular tumors [8,9]. Transmeatal approach is an essential element of retrosigmoid surgery whenever a VS has some intracanalicular components. To expose these components and intracanalicular portions of cranial nerves VII and VIII, posterior wall of the internal auditory canal (IAC) needs to be removed. However, this can be challenging owing close vicinity of the labyrinth block, located posteriorly to the IAC fundus [9]. Consequently, complete resection of a tumor which penetrates to the fundus, and inspecting ''hidden corners'' of the latter for potential residual malignancy may be at least difficult under a straight microscopic view. This problem can be overcome with micro-endoscopy; the use of this technique results in total gross removal in most cases and provides satisfactory outcomes in terms of facial nerve and hearing preservation [1,8,9].

In this technical note, we present RT approach with an endoscopic assistance and highlight its advantages over MF approach in surgical management of pure intracanalicular VSs.

2. Material and methods

We fix patient's head in three-pin Mayfield clamp. Unlike in most subjects with T3-T4 lesions, patients with T1 pathologies are placed in a supine position with the head tilted contralaterally to the tumor side as much as possible but without compression of the jugular veins (Fig. 1). All patients are routinely placed under an intraoperative monitoring including SEP, MEP, FMEP, direct intraoperative facial stimulation and AEP.

The skin is incised starting from the pinna to ca. 1 cm below the mastoid tip, approximately two fingerbreadths behind the ear. Skin, subcutaneous, superficial and deep muscles are opened in layers, with sparing of both the lesser and greater occipital nerve. The extent of soft tissue dissection should be sufficient to expose the asterion, mastoid tip and the line connecting vertical and horizontal part of the occipital bone. Subsequently, one burr hole is made just inferomedial to the asterion, and then, as an option another one below the former.

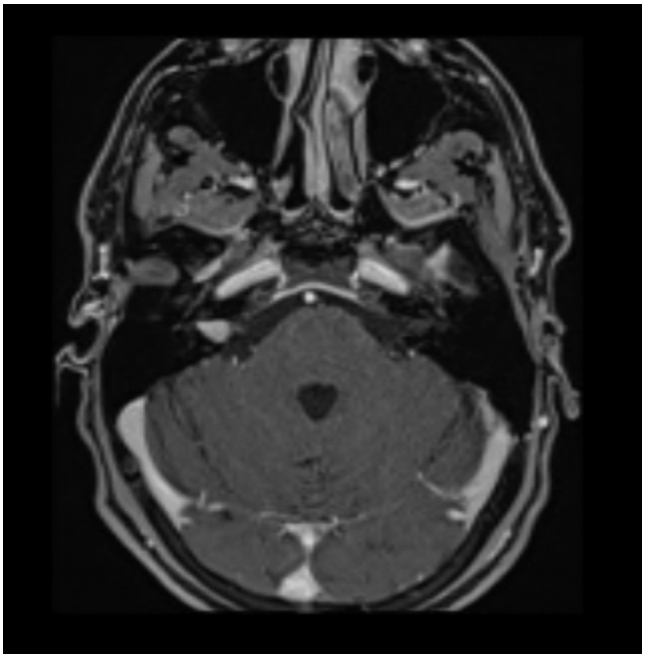

Fig. 1 – Contrast-enhanced MRI documenting presence of pure intracanalicular vestibular schwannoma, T1 according to Samii classification from 2007.

Next, retrosigmoid craniotomy/craniectomy, approximately 3 cm × 3 cm, is fashioned to expose the sinus knee, inferior edge of the transverse sinus, medial border of the sigmoid sinus and horizontal segment of the occipital squama.

Then, a semilunar cut is made in the dura, parallel to the sigmoid sinus. We proceed to an small opening the cerebromedullary cistern, to provide a drainage of cerebrospinal fluid. Then spatula fixed on the retractor is inserted. The next crucial step is identification of the IAC line. Unlike in subjects with large vestibular schwannomas, IAC can be easily localized in most patients with T1 tumors, even without Tübingen line landmark [10]. The dura is opened with another semilunar cut starting at this landmark, and detached. Then, the whole 180-degree circumference of IAC is exposed with a high-speed diamond drill (medium and then small size) beginning from the lateral portion of the canal and proceeding medially. The extent of exposure depends on patient's hearing status; depth of tumor invasion and individual relation between IAC and inner ear structures evaluated on preoperative thin-slice CT scans. If a high jugular bulb was found on the preoperative imaging, the decision to open IAC or not should be based on a careful risk-benefit evaluation. Exposed dura inside the IAC is cut longitudinally, and intrameatal part of the tumor is removed partially to facilitate identification of the facial nerve. Bipolar coagulation should be limited to a necessary minimum, especially in close proximity of the nerves. Throughout the whole procedure, surgical field is irrigated with warm physiologic solution. Completeness of the resection is verified by means of endoscopic inspection of the lateral part of IAC, and integrity of the mastoid is confirmed with both microprobe and endoscope. Then, watertight running suture is placed on the dura, craniotomy is filled with a gelfoam sponge

and methyl methacrylate plastic, and soft tissue wound is closed in layers.

3. Results

Using the hereby described retrosigmoid transmeatal approach, we were able to expose IAC in its entire 180-degree circumference and 10-mm length [2,11] (Fig. 2). Based on our experiences, straight microscopic view does not provide an adequate insight into the most lateral part of IAC and therefore, completeness of the resection cannot be verified unequivocally (Fig. 3). Insertion of at least 30-degree angled endoscope enabled us to visualize entire IAC, down to its fundus, and to identify a residual tumor (Fig. 4). As a result, the lesion could be removed completely under an endoscopic guidance [9,11] (Figs. 5 and 6). Then, we used the endoscope to verify the integrity of the mastoid, and to confirm that all opened air cells (if any) have been closed appropriately (Fig. 7). Such approach allowed us to use only a wax, rather than recently harvested muscle and glue, which is known to impair scar tissue formation in close vicinity of nerves VII and VIII and can imitate a residual tumor tissue on a follow-up scans (Fig. 8).

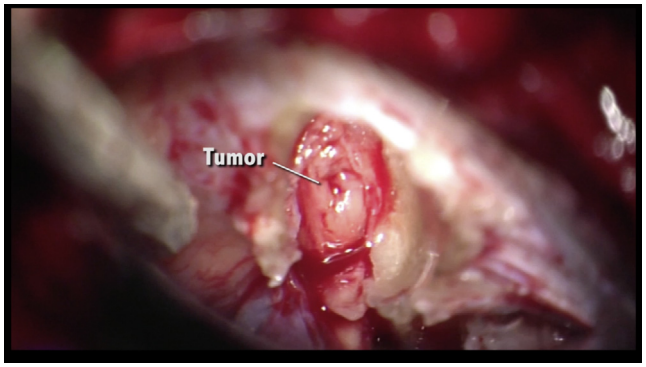

Fig. 2 – Microscopic view of a pure intracanalicular vestibular schwannoma inside the inner auditory canal (IAC) opened using transmeatal retrosigmoid approach.

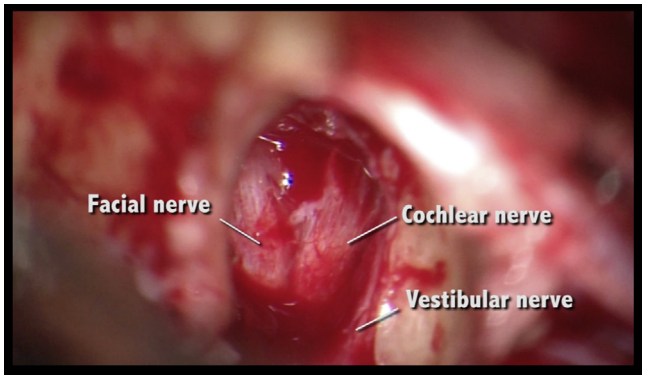

Fig. 3 – Microscopic view of IAC following resection of the tumor. Completeness of the resection could not be verified due to limited visibility of IAC fundus.

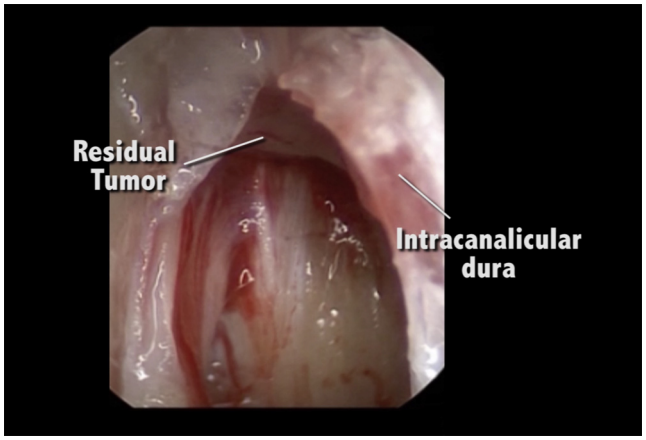

Fig. 4 – Endoscopic view on entire IAC, including the fundus. Residual tumor present in IAC fundus, non-visible under a straight microscopic view, has been identified with an endoscopic assistance and removed completely.

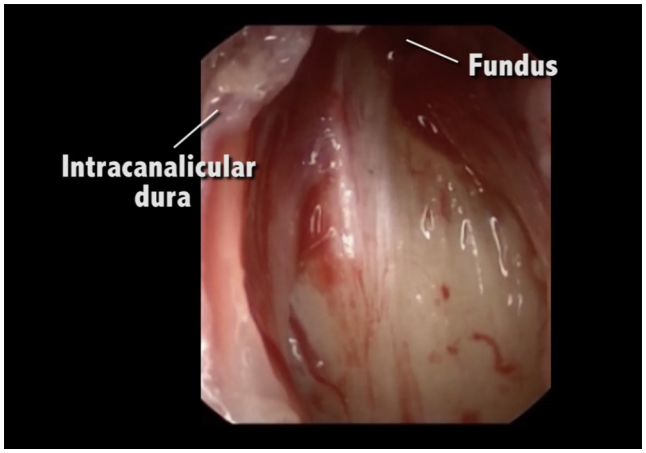

Fig. 5 – Endoscopic view of entire IAC after complete resection of intracanalicular schwannoma.

4. Discussion

RT and MF approaches are the only surgical options in patients with VSs, in whom hearing preservation is of paramount importance [12]. While RT is used in most patients with extracanalicular extension of VSs, the choice between this technique and MF approach in subjects with pure intracanalicular tumors is still a matter of discussion [2,5,12]. However, a growing tendency to use MF approach in this indication has been observed recently. For example, Kumon et al. and Nonaka et al. compared the outcomes of RT and MF surgeries in patients with small acoustic neurinomas; all subjects with pure intracanalicular tumors in this series were operated on using the MF approach [2,5]. A large number of proponents of this technique in some centers was reflected by the paper published by Coletti et al. entitled ''Is the middle fossa approach the treatment of choice for intracanalicular vestibular schwannoma?'' [13].

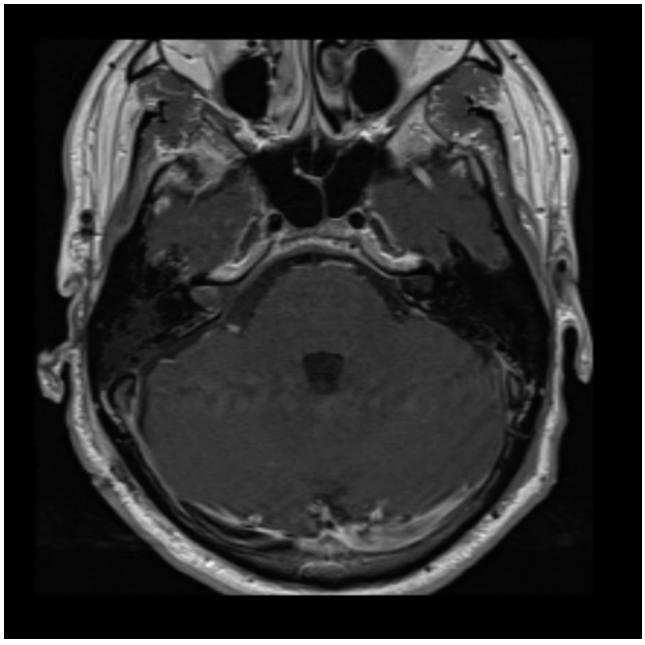

Fig. 6 – Follow-up MRI confirming complete resection of intracanalicular vestibular schwannoma.

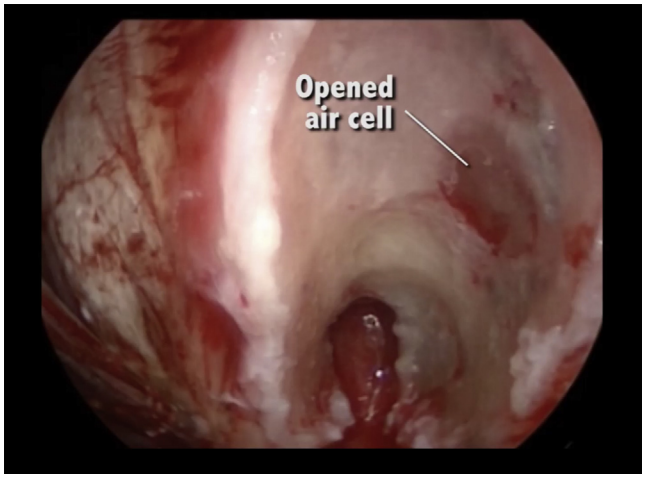

Fig. 7 – Endoscopic verification the integrity of the mastoid confirmed that one air cell has been opened.

RT approach is a well-known technique used in patients with VSs of any grade, from T1 to T4. Retrosigmoid transmeatal approach has been improved during last decades due to constant progress in microsurgical technique and instrumentation, especially intraoperative monitoring, and identification of new anatomical landmarks [11,14]. RT approach has a number of advantages that make it superior to MF technique. Neurosurgeons are with no doubt more familiar with this technique as they practice it virtually from the beginning of their residency training [14]. Since identification of crucial anatomical landmarks, such as Tübingen line, and opening of the inner auditory canal are currently more accurate and safer, which is of paramount importance in patients with preserved hearing [10]. Further, RT approach provides better proximal

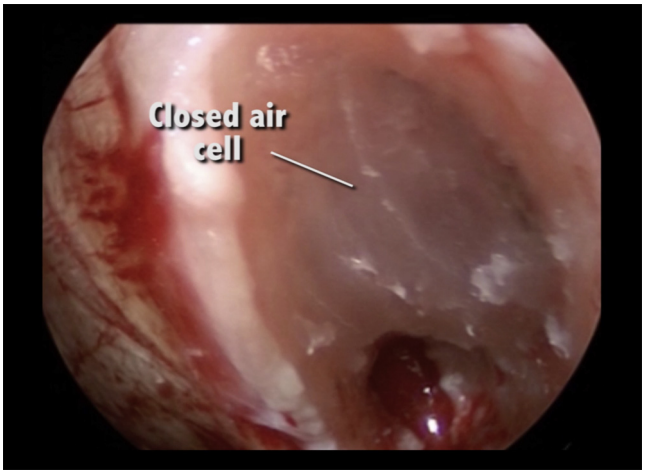

Fig. 8 – Opened air cell has been sealed with wax.

control of cranial nerves VII and VIII, as well as some insight in their topography and relation to the tumor within the IAC [11]. Although according to many authors, this approach carries a lower risk of facial nerve injury, some evidence suggests that it also provides lower rates of hearing preservation than MF technique [12,15,16]. However, Roser et al. achieved very good results in terms of facial nerve preservation (no facial palsy with T1-T3) in a series of 50 patients operated on using the RT approach, and contrary to many other authors, reported high rate of functional hearing preservation (66% in T1-T2 tumors) [5]. RT approach was shown to be suitable for complete resection of most purely intrameatal tumors [2]. However, a tumor reaching down to the fundus of IAC may not be seen well under a straight microscopic view, since compared to MF approach, RT technique provides a worse insight in the lateral IAC [17]. Due to technological progress and growing availability of multivariable rigid endoscopes with 0- to 120-degree angles, application of endoscope-assisted surgeries is still expanding. Advantages of endoscopic guidance in achieving gross total resection of cerebellopontine angle tumors, especially intrameatal lesions, have been recognized already 20 years ago by the senior author of this paper [9]. Endoscopic guidance provides the operator with a detailed insight in the anatomy of the internal meatus down to its fundus, is helpful in identification of any exposed air cells and prevention of resultant fistula complications; all these beneficial effects can be obtained with almost no retraction of the cerebellum [11,18]. However, application of RT approach may be limited whenever a high jugular bulb and anterior inferior cerebellar artery (AICA) are present in close vicinity of IAC, hindering its easy and safe dissection.

MF approach is generally better known among otologists. As initial symptoms of VS include unilateral hearing loss (98%) and tinnitus (70%), most patients with such ailments are first referred to an otologist, and some of them may be qualified for surgical treatment with MF approach [19]. Aside its advantages mentioned above, we would also like to highlight some potential drawbacks of MF approach, such as the need for larger craniotomy and resultant worse cosmetic result, and extradural dissection of the middle fossa associated with increased risk for greater and superficial petrosal nerve injury.

In addition, there are increased risk for nerve VII injury and the retraction of temporal lobe, which with no doubt constitute principal disadvantages of this technique [6]. Patients who have been operated on using MF approach may develop neurologic and psychologic deficits and are at increased risk of secondary epilepsy due to temporal lobe gliosis [7]. While temporal gliosis should be expected in a large proportion of patients, it is mild or moderate in most cases. Nevertheless, potential risk for a severe temporal lobe gliosis with resultant functional deficits still need to be considered in subjects operated on using MF approach [20]. Although MF surgeries can be also performed under an endoscopic guidance, published evidence in this matter is limited to only two patients and therefore is insufficient to formulate any definitive conclusions [15].

In this paper, we discussed well-documented advantages and disadvantages of both RT and MF approach. As neurosurgeons, we prefer RT approach over the MF technique as the former provides safe access to pure intracanalicular VSs, enabling their complete resection under an endoscopic guidance [21]. Owing a few important drawbacks of MF approach, we postulate that at least a neurosurgical consultation should be sought by an otologist before making an ultimate decision to use this technique. In our opinion, an indication to the use of MF approach in patients with T1 tumors may be presence of high jugular bulb and AICA fixed to the wall of meatus, as it makes treatment with RT technique hazardous.

Conflict of interest

None declared.

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None declared.

Ethics

The work described in this article has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans; Uniform Requirements for manuscripts submitted to Biomedical journals.

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