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An electrophysiological study on the safety of the endoscope-assisted microsurgical removal of vestibular schwannomas

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Abstract

Background: Endoscopy is being increasingly used in skull base surgery. The issue of its safety, however, has not been definitely solved.
Methods: We evaluated the risk of thermal or mechanical iatrogenic nerve injury related to endoscope application during microsurgical removal of vestibular schwannomas (VS) in a prospective group of 30 patients (Group A). Main analysed parameters were electrophysiological monitoring data (auditory evoked potentials and EMG) during and after endoscopic observation. The structural and functional preservation of facial and cochlear nerves, radicality of tumour removal, and CSF leak rate were evaluated and compared to historical group of 50 patients (Group B), operated consecutively with classical microsurgical technique.
Results: No electrophysiological changes directly related to endoscope were registered. The rate of loss of waves I, II, and V did not depend on application of endoscope and was similar in both groups. The functional and general outcome was also similar. Endoscopic inspection provided early and detailed view of anatomical relations within cerebellopontine angle and internal auditory canal and confirmed completeness of tumour removal. Total tumour removal was achieved in all patients from Group A and in 49/50 from Group B. Useful hearing after the surgery had 17/30 patients in Group A and 26/50 in Group B.
Conclusions: The application of endoscope during microsurgical removal of VS is a safe procedure that does not lead to heat-related or mechanical neural or vascular injuries. The actual significance of this additional endoscopic information, however, is related to the particular operative technique and experience of the surgeon.

Keywords: Vestibular schwannoma; Endoscope - assisted microsurgery; Retrosigmoid approach; Intraoperative electrophysiological monitoring

The endoscope is an established component of contemporary brain tumour surgery armamentarium. Its application in various skull base procedures, either as a sole visualizing tool or as an adjunct to the microscope, is constantly expanding.[1] The endoscope provides superior illumination and magnification, as well as possibility ‘‘to look around the corner’’, thus allowing for more radical but safe surgeries.[2] The endoscope-assisted microsurgery (EAM) combines the advantages of both the classical microneurosurgery and endoscopy. Its application in case of lesions located in cerebellopontine angle (CPA), offers the possibility to identify at an early stage various structures and their relations, as well as to look for hidden tumour parts.[3] In case of vestibular schwannomas (VS) the whole internal auditory canal (IAC) up to its fundus can be inspected without increasing the risk of violation to the bony labyrinth; thus tumour remnants or opened air cells are readily visualized.[4–8]

The issue of the safety of the endoscopic technique, however, has not been definitely solved. When inserting the endoscope through the complex lattice of nerves and vessels in the CPA, a risk of mechanical injury exists.[9] The close observation of vulnerable structures, such as cranial nerves or tiny vessels, exposes them to a potential risk of thermal injury from the heat generated by the light of the endoscope. Although a general awareness of these risks exists,[4,8,10,11] their clinical significance has not been addressed systematically. The goal of the current study was

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to evaluate the safety of the EAM technique and the outcome after its application in a prospective series of patients with VS.

Methods and patients

A prospective study was performed that included 30 patients with VS operated via the retrosigmoid approach with the EAM technique. The inclusion criteria were: presence of unilateral sporadic vestibular schwannomas, age above 20 years, primary surgery, normal facial nerve function, and presence of functional hearing on the involved side preoperatively. Patients with neurofibromatosis type 2, previous surgical or radiosurgical treatment, previous infectious diseases of the brain, facial palsy and/or severe hearing loss, have been excluded. The Hannover VS extension classification system was applied.[12] Facial nerve function was assessed using the House–Brackmann grading system.[13] Hearing was graded according to the New Hannover Classification. Hearing Classes H1 to H2 with pure tone average of up to 40 dB and speech discrimination score more than 70%, were accepted as functional hearing levels.[14]

The evaluated parameters were: structural and functional preservation of the facial and cochlear nerves, the data from the electrophysiological monitoring, radicality of tumour removal, and CSF leak rate. The results in this group (Group A) have been compared to a historical group of 50 patients, operated consecutively with the classical microsurgical technique, that corresponded to the inclusion criteria of the current study (Group B).

Operative technique: in all cases the retrosigmoid approach was used with the patient in semi-sitting position. The details of the technique have been discussed in detail previously and only the main steps are highlighted here.[12,15] The goal of surgery has always been to achieve complete tumour removal but preservation of all neurological functions had a priority. A retrosigmoid craniotomy has been performed exposing the edges of the transverse and sigmoid sinuses. A slightly curved dural incision along the sinuses has been done and the lateral cerebellomedullary cistern was opened to allow sufficient egress of CSF. Thus, a minimal brain retraction was necessary. The intrameatal tumour portion was approached initially by removing the posterior wall of the IAC. The dissection of the tumour from cranial nerves and other neural structures was performed only after sufficient tumour debulking. The tumour was dissected from surrounding neural and vascular structures by gripping the tumour capsule only and dissecting it in the level of the arachnoid plane. After the removal of the tumour, multiple fat pieces have been used to plug the drilled IAC and were sealed with fibrin glue.

Neurophysiological monitoring: continuous electrophysiological monitoring using a commercially available hardware and software (Endeavor CR intraoperative monitor; VIASYS Healthcare, Nicolet Biomedical, Madison, WI) provided feedback regarding the functional integrity of the facial and cochlear nerves.[14,15] The cochlear nerve function was assessed with brainstem auditory evoked potentials (BAEP): the needle electrodes were placed anteriorly to the tragus on both sides for registering of the potentials. The acoustic stimulation was done by generating alternate click noises, transferred with tubal insert phones (300-V stimulators) for intraaural stimulation. On the tumour side 100 dB normal hearing level stimulus and a 70 dB normal hearing level noise on the other side were applied (100 msec stimulus duration and 0.01 Hz stimulus frequency). Input characteristics for acquiring evoked potentials were: 10,000 amplification rate, 1000 averaged sweeps, 150 Hz to 1.5 kHz filter, 0.2 mV sensitivity, and 10 msec duration of signal acquisition. The BAEP findings were classified according to Nordstadt's ABR typing system, consisting of Types B1 through B5, which are determined by the presence of waves I to V, their amplitude and latency.[16] The facial nerve function was monitored with EMG recordings of the orbicularis oris and oculi muscles and the input characteristics for acquiring the EMG signals were: 5000 amplification rate, 10 Hz to 1.5 kHz filter, 50 mV sensitivity, and 2-second duration of signal acquisition.

Endoscopic observation: A rigid rod-lens endoscope with an outer diameter of 2 mm and length of 26 cm with lens degree of 0 and 30° have been used (Karl Storz GmbH, Tuttlingen, Germany). They have been introduced in the CPA at different stages of VS dissection and removal for inspection of the relations of the tumour to surrounding neurovascular structures and for identification of cranial nerves and vessels. The endoscope was introduced freehand under microscopic visual control (Fig. 1). After tumour removal, the lateral end of IAC has been inspected in order to look for residual tumour parts and/or opened mastoid air cells. The effect of this procedure on the facial and cochlear

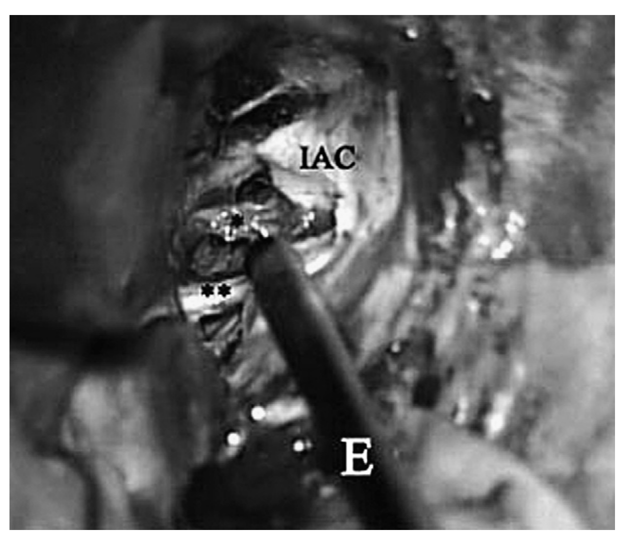

Figure 1. Microscopic view of the position of the endoscope shaft (E) in the CPA. The facial (*) and the cochlear (**) cranial nerves are seen in both their cisternal and intracanalicular segments. IAC – internal auditory canal; F- fundus of the IAC; R – retractor, holding the cerebellar hemispere.