Middle Fossa Approach for Vestibular Schwannoma: Good Hearing and Facial Nerve Outcomes with Low Morbidity

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■ OBJECTIVE: **The middle fossa approach (MFA) is not used as frequently as the traditional translabyrinthine and retrosigmoid approaches for accessing vestibular schwannomas (VSs). Here, MFA was used to remove primarily intracanalicular tumors in patients in whom hearing preservation is a goal of surgery.**

■ METHODS: **A retrospective chart review was performed to identify consecutive adult patients who underwent MFA for VS. Demographic profile, perioperative complications, pre- and postoperative hearing, and facial nerve outcomes were analyzed with linear regression analysis to identify factors predicting hearing outcome.**

■ RESULTS: **Among 78 identified patients (mean age, 49 years; 53% female; mean tumor size, 7.5 mm), 78% had functional hearing preoperatively (American Academy of Otolaryngology—Head and Neck Surgery class A/B). Follow-up audiologic data were available for 60 patients overall (mean follow-up, 15.1 months). The hearing preservation rate was 75.5% (37/49) at last known follow-up for patients with functional hearing preoperatively. Other than preoperative hearing status ($P < 0.001$), none of the factors assessed, including demographic profile, size of tumor, and fundal fluid cap, predicted hearing preservation ($P > 0.05$). Good functional preservation of the facial nerve (House-Brackmann class I/II) was achieved in 90% of patients. The only operative complications were 3 wound infections (3.8%).**

■ CONCLUSIONS: **Preliminary results from this single-center retrospective study of patients undergoing MFA for resection of VS showed that good hearing preservation and facial nerve outcomes could be achieved with few complications. These results suggest that resection via the MFA is a rational alternative to watchful waiting or stereotactic radiosurgery.**

INTRODUCTION

Vestibular schwannomas (VSs) account for ∼8% of intracranial tumors encountered in neurosurgery practice.[1] They arise at the Obersteiner-Redlich transition zone of vestibular nerves.[2] Hearing loss, tinnitus, vertigo, dizziness, and imbalance are the most common presentations.[3] Among the various theories pertaining to the mechanism of hearing loss in VSs are tumor-induced pressure in the internal acoustic canal (IAC), vascular compromise, cochlear hair cell loss, and altered composition of fluids within the inner ear.[4] The widespread use of magnetic resonance imaging of the brain for unrelated indications has led to early diagnosis of VS tumors with smaller size in patients with intact hearing. The 3 treatment options for such patients are expectant observation, stereotactic radiosurgery (SRS), and microsurgery.[5,6]

Conservative management with watchful waiting is typically reserved for small tumors in patients with minimal or no symptoms, poor overall health, or advanced age.[4-6] Because hearing

Key words
- Facial nerve outcome
- Hearing preservation outcome
- Middle fossa approach
- Vestibular schwannoma

Abbreviations and Acronyms
AAO-HNS: American Academy of Otolaryngology—Head and Neck Surgery
CSF: Cerebrospinal fluid
FN: Facial nerve
GSPN: Greater superficial petrosal nerve
HB: House-Brackmann
HPR: Hearing preservation rate
IAC: Internal acoustic canal
MFA: Middle fossa approach
PTA: Pure tone audiometry
RS: Retrosigmoid
SRS: Stereotactic radiosurgery
VS: Vestibular schwannoma
WRS: Word recognition score

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loss over time is expected with conservative management, most young and middle-aged patients with even minimal symptoms tend to choose SRS or microsurgical resection for better long-term hearing outcomes.[4-6] Conventionally, SRS has been used for small tumors (<2.5 cm), tumors in older patients, and recurrent/residual VS.[4-6] Initial reports suggested that SRS offered better facial nerve (FN) and hearing preservation rates (HPRs) than corresponding microsurgical resection for such patient groups, but adequate long-term data are still missing. Microsurgery is classically reserved for symptomatic, younger patients with good overall functional performance status.[4-6] Tumor size is usually not a barrier for surgical intervention, although it is a limitation with SRS.

The choice of microsurgical approach for VS tumors depends on the tumor size, patient age, tumor site and extent of IAC involvement, anatomy of the vestibule, amount of tumor extension in the cerebellopontine angle, brainstem involvement, preoperative status of FN function and hearing status, and surgeon's preference.[4-7] The availability of superior microscopes, safer high-speed drills, better hemostatic agents, and intraoperative neuromonitoring have led to an evolution in the goals of microsurgery for VS, which have progressed from preserving life to preserving FN function[8] and to hearing preservation.[9,10] Whereas the translabyrinthine approach sacrifices hearing to achieve greater exposure, the middle fossa approach (MFA) and retrosigmoid (RS) approaches to resection of VS tumors offer the possibility of hearing preservation.[7] House[11,12] developed the MFA in the early 1960s for the decompression of the auditory nerve in cases of advanced otosclerosis. He later adapted this technique for VS resection.[13] The advantages of this approach over the RS approach were better HPRs, lower incidence of postoperative headache, improved exposure of the lateral IAC, and completion of bone drilling before dural opening[4-7,10]; however, limitations include limited exposure of posterior fossa, difficulty in resecting larger tumors, higher incidence of transient facial paresis, risk of seizures, and possible language impairment in the dominant temporal lobe.[4-7,10] In part because of these limitations, the MFA is not used as frequently as the retrosigmoid approach. We present our experience with MFA for resection of small VS tumors (primarily intracanalicular) in patients in whom hearing preservation is a goal of surgery.

METHODS

Study Design

We performed a retrospective chart review to identify consecutive adult patients (>18 years) who underwent MFA for VS at the University of Utah from January 2000 to December 2015. Institutional ethics committee approval was obtained before starting data collection. Demographic profiles, perioperative complications, and pre- and postoperative hearing and FN outcomes were analyzed. For the assessment of hearing status, we used the 1995 American Association of Otorhinolaryngology—Head and Neck Surgery (AAO-HNS) classification for hearing and equilibrium.[14] House-Brackmann (HB) grading was used to assess FN function.[15] Both pure tone audiometry (PTA) and word recognition scores (WRS) were assessed pre- and postoperatively to ascertain hearing classification. The primary outcome of this study was HPR assessment, where HPR was defined as the proportion of patients who retain functional hearing (AAO-HNS class A/B) after surgical resection of tumor at the last known follow-up. The secondary outcomes of this study were assessment of functional preservation of the FN (HB class I/II) after surgical resection, factors predicting FN and hearing outcome, and complication rates.

Operative Technique

After general anesthesia is induced, the patient's head is positioned in Mayfield 3-pin fixation, such that the sagittal sinus is parallel to the floor. Intraoperative FN and auditory brainstem response monitoring are routinely performed. A lazy S—shaped incision is made from a point anterior to the tragus (corresponding to the root of the zygoma) inferiorly, reaching up to the superior temporal line superiorly. Temporal bone is then exposed using a muscle splitting technique for temporalis muscle and subperiosteal dissection. A small 5-cm × 5-cm craniotomy is positioned two thirds anterior and one third posterior to the external auditory canal, centered over the root of the zygoma. The temporal base is drilled to make it flush with the middle cranial fossa. By using the bony landmark of the zygomatic root, the middle meningeal artery is identified, coagulated, and divided. The basal dura mater is reflected in a posterior to anterior direction to prevent undue traction on the greater superficial petrosal nerve (GSPN) and geniculate ganglion.

Once the arcuate eminence and GSPN are well exposed, malleable retractors are placed behind the true petrous ridge and Meckel cave. Unnecessary coagulation around the GSPN is avoided to prevent FN paresis. Next, the arcuate eminence is identified. Typically, the IAC bisects the angle between the orientations of the superior semicircular canal and GSPN. Drilling along this line at the petrous edge exposes the IAC dura mater and Bill bar separating the facial and vestibular nerves. Care is taken not to violate the cochlea, which is located immediately anterior to the lateral aspect of the IAC. Once the porus is opened, the geniculate ganglion and intralabyrinthine FN in the fallopian canal are completely skeletonized to allow gentle maneuverability around the FN in a tight operative corridor and to reduce facial neurapraxia incidence, providing adequate exposure of the lateral aspect of the IAC. Drilling is continued until 200°—270° of the IAC is exposed, allowing adequate working space. This decompression of the canal also enables better mobilization of the tumor without causing compression of the adjacent nerve (Video 1).

Video

Video available at WORLDNEUROSURGERY.org

The transverse crest can limit visualization of the inferior half of the fundus, especially for tumors arising from the inferior vestibular nerve. In addition, the oblique angle of the surgical corridor may warrant blind dissection of the IAC floor; therefore, it is advisable to adequately reflect the temporal lobe to provide a straighter trajectory. Appropriate use of reverse Trendelenburg positioning, mannitol bolus, and hyperventilation usually assists in reaching the above-mentioned trajectory. Subsequently, the IAC dura mater is opened at its posterior aspect to prevent accidental damage to the underlying FN, which lies in the anterosuperior aspect. After cerebrospinal fluid (CSF) egress, the stimulating probe is used to