Exposing the Fundus of the Internal Acoustic Meatus without Entering the Labyrinth Using a Retrosigmoid Approach: Is It Possible?

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■ OBJECTIVES: **To evaluate the feasibility of performing a labyrinth-sparing neuronavigation-assisted retrosigmoid approach to the fundus of the internal acoustic meatus (IAM) and to describe the anatomy of the structures embedded in the posterior meatal wall.**

■ METHODS: **Ten surgical dissections were performed bilaterally on 5 fresh cadavers. Cadavers were subjected to preoperative computed tomography scans and spatial coordinates of inner ear structures were recorded. A retrosigmoid craniectomy was performed. The IAM was drilled towards the fundus until no more than 1 mm of bone covered the labyrinthine structures. Specimens underwent a new computed tomography scan to verify the length of opened IAM and the status of the labyrinth. We then opened the labyrinthine structures and recorded their coordinates using navigation. These were compared with the radiologic coordinates to verify the neuronavigation accuracy.**

■ RESULTS: **In 9 sides, the IAM was opened to the fundus without injuring the labyrinth; in 1 side, the vestibule was opened. The mean residual bone on the fundus was 0.97 mm. The average length of the accessible IAM was 88.95%. The best accuracy of the navigation was for the identification of the common crus, with a mean value of 0.73 mm.**

■ CONCLUSIONS: **This surgical technique could facilitate the opening of the IAM with preservation of inner ear structures. We opened a mean of 88.95% of the IAM without entering the labyrinthine structures in 90% of cases. These results confirm the feasibility of the retrosigmoid approach for the exposure of the IAM fundus with preservation of labyrinthine structures.**

INTRODUCTION

The use of the retrosigmoid transmeatal approach to completely remove vestibular schwannoma and preserve hearing is still debated in the skull base literature.[1-3] The middle fossa and translabyrinthine approaches are 2 other commonly used approaches to the cerebellopontine angle and internal acoustic meatus (IAM).[4,5] The middle fossa approach presents the following advantages: better hearing preservation for size-matched groups of intracanalicular tumors and tumors extending 1 cm or less into the CPA, no cerebellar retraction,

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- Acoustic neuroma
- Fundus
- Inner ear
- Internal acoustic meatus
- Neuronavigation
- Retrosigmoid approach
- Semicircular canals

Abbreviations and Acronyms
AFB: Acoustic-facial bundle
aPSC: Anterior part
CC: Common crus
ES: Endolymphatic sac
F: Fundus of internal acoustic meatus
IAM: Internal acoustic meatus
IIAM: Inferior lip of internal acoustic meatus
IX: Entry point of IX cranial nerve in the jugular foramen
LCN: Lower cranial nerves
LSC: Lateral semicircular canal
O: Opercule of endolymphatic sac
PIAM: Posterior lip of the internal acoustic meatus
pPSC: Posterior part of posterior semicircular canal
PSC: Posterior semicircular canal
SD: Standard deviation
SIAM: Superior lip of internal acoustic meatus
SSC: Superior semicircular canal
VA: Vestibula aqueduct
VE: Vestibule

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enhanced lateral exposure facilitating dissection in a lateral to medial direction, and better development of tumor arachnoid planes at the fundus.[6] The translabyrinthine approach is preferred in patients with nonserviceable hearing and with large tumors who have a low probability of hearing preservation. It offers early identification of the facial nerve in the auditory canal during surgery and cerebellar retraction is not needed.[7] The retrosigmoid approach is considered more versatile, enabling removal of tumors largely independent of size and offering the surgeon improved access to the root entry zone of the acoustic nerve. One of the main criticisms has to do with the ability to reach the fundus of the IAM and to preserve the labyrinth structures embedded in the posterior meatal wall.[8] Many studies have described anatomic landmarks and techniques for safe drilling of the posterior meatal wall[8-13] but few[2] reports deal with this drilling via a retrosigmoid approach or with the use of intraoperative neuronavigation.[14,15]

The goal of our study was to perform an anatomic, radiologic, image-guided study of the anatomy of the inner ear structures embedded in the posterior meatal wall and to describe their relationships to the IAM using a retrosigmoid approach. More importantly, we endeavored to integrate all this information in evaluating the usefulness of the retrosigmoid approach in performing extensive labyrinthine sparing drilling of the posterior wall of the internal auditory meatus.

METHODS

Ten surgical dissections were performed bilaterally on 5 fresh cadaver heads. Six titanium microscrews were implanted onto the skull as permanent bone-reference markers. Cadavers were then subjected to high-resolution bony computed tomography (CT) (slice thickness, 0.6 mm; contiguous nonoverlapping slices). The CT scanning was performed at a gantry of 0°, with a scan window diameter of 225 mm and a pixel size of more than 0.44×0.44. Before performing the dissections, measurements of landmarks and distances between the important topographic structures of the petrous bone were taken on preoperative CT (Figure 1A).

The specimens were divided in 3 categories according to the sigmoid-fundus line (Figure 1B)[15]: the L group, in which the most medial extension of the labyrinth is lateral to the sigmoid-fundus line; and the O group, in which it is on the sigmoid-fundus line; and the M group, in which it is medial.

We defined a safety line as a line going at least 1 mm parallel to the vestibule, from the fundus to the occipital bone (similar to the fundus-labyrinth line reported by Mazzoni et al.[16]). Along this line, we considered the drilling safe. Intersection of the line on the petrous bone surface was defined as F1 (Figure 1B). The extension of this line on the occipital bone was called F2.

We used a Stryker Navigation System (Kalamazoo, Michigan, USA) for intraoperative navigation.

Surgical Procedure

The heads were placed on a Mayfield head-holder in a semisitting position (the same position we use in the operating room).

A standard retrosigmoid craniectomy was performed on both sides of each of 5 cadaveric heads. The size of the craniotomy was

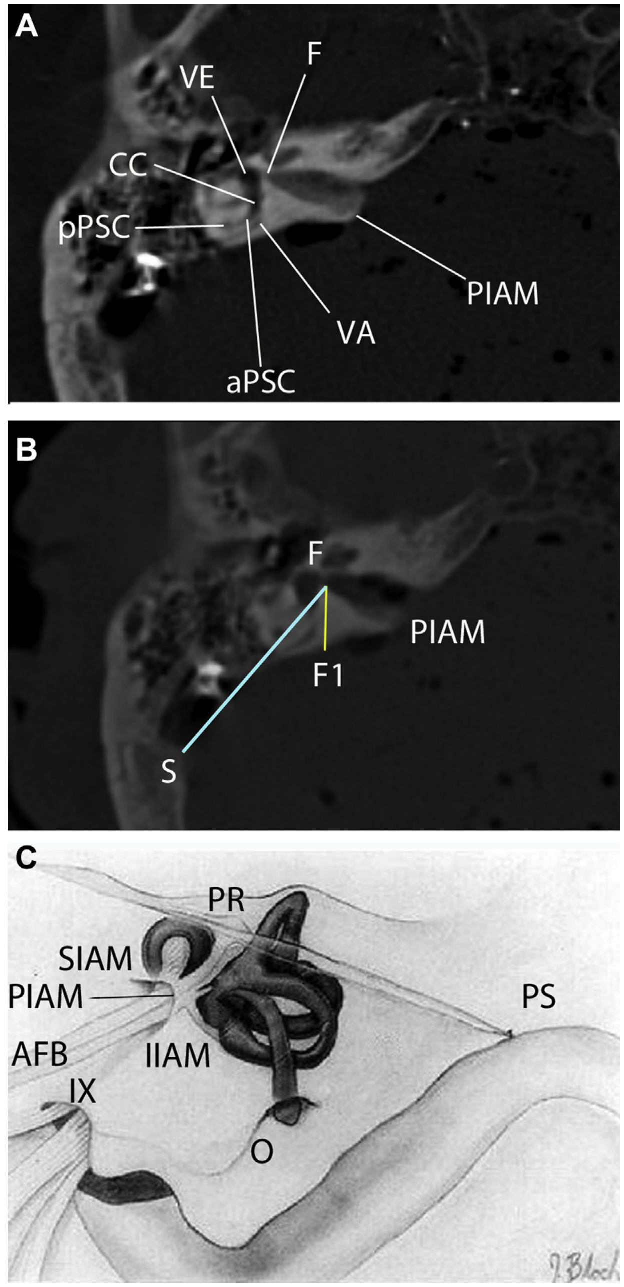

Figure 1. Computed tomography scan and anatomic landmarks (**A**) Landmarks identified and digitized on computed tomography scan. (**B**) The yellow line, going from the fundus to the petrous surface parallel to the vestibule, represents our safety line. Its intersection with the pyramid surface is the point F1; the light blue line is the sigmoid-fundus line (see the Methods section). (**C**) Landmarks identified and digitized on petrous bone surface. AFB, acoustic-facial bundle; aPSC, anterior part of the posterior semicircular canal; CC, common crus; F, fundus of IAM; F1, projection of the fundus on the petrous bone surface along the safety line; IIAM, inferior lip of internal acoustic meatus; IX, entry point of IX cranial nerve in the jugular foramen; O, opercule of endolymphatic sac; PIAM, posterior lip of internal acoustic meatus; pPSC, posterior part of the posterior semicircular canal; PR, petrous ridge; PS, petrosigmoid intersection; S, sigmoid; SIAM, superior lip of internal acoustic meatus; VA, vestibular aqueduct; VE, vestibule. Adapted from Ammirati et al.[26] with permission from the American Association of Neurological Surgeons.