Endoscopically Assisted Drilling, Exposure of the Fundus through a Presigmoid Retrolabyrinthine Approach: A Cadaveric Feasibility Study

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No sponsorships or competing interests have been disclosed for this article.

Abstract
The presigmoid retrolabyrinthine approach to the cerebellopontine angle (CPA) is traditionally described to not provide access to the internal auditory canal (IAC). We aimed to evaluate the extent of the IAC that could be exposed with endoscopically assisted drilling and to measure the percentage of the IAC that could be visualized with the microscope and various endoscopes after drilling had been completed. Presigmoid retrolabyrinthine approaches were performed bilaterally on 4 fresh cadaveric heads. We performed endoscopically assisted drilling to expose the fundus of the IAC, which resulted in exposure of the entire IAC in 8 of 8 temporal bone specimens. The microscope afforded a mean view of 83% (n = 8) of the IAC. The 0°, 30°, 45°, and 70° endoscope each afforded a view of 100% of the IAC in 8 of 8 temporal bone specimens. In conclusion, endoscopic drilling of the IAC can provide an extradural means of exposing the entire length of the IAC while preserving the labyrinth.

Keywords
retrolabyrinthine, presigmoid retrolabyrinthine, endoscope, endoscopic drilling, internal auditory canal, labyrinth preservation, skull base

Received May 5, 2017; revised August 8, 2017; accepted September 6, 2017.

The presigmoid retrolabyrinthine approach to the cerebellopontine angle (CPA) was first described by Hitselberger and Pulec1 in 1972 and later elaborated by Silverstein and Norrell,² Silverstein et al,³ House et al,⁴ and McElveen et al.⁵ Its advantages include extradural drilling of bone, less need for cerebellar or temporal lobe retraction, and direct access to the CPA. Its primary advantage over other transpetrosal approaches is the preservation of the labyrinth, thereby preserving hearing or allowing for the possibility of implanting a cochlear device. The approach has been used for vestibular nerve sectioning, endolymphatic duct surgery, as part of a combined approach, and as the sole approach for tumor resection. The major disadvantage of the presigmoid retrolabyrinthine approach is the potential for limited exposure of the CPA.

This approach traditionally does not provide access to the internal auditory canal (IAC) and is performed with microscopic visualization. We sought first to evaluate the extent of the IAC that could be exposed with endoscopically assisted drilling and second to measure the percentage of the IAC that could be visualized with the microscope and various endoscopes after drilling had been completed.

Materials and Methods
This project was exempt from the institutional review board (IRB). Four fresh cadaveric human heads underwent a bilateral presigmoid, retrolabyrinthine approach. We used 3-mm × 14-cm endoscopes (Karl Storz, Tuttlingen, Germany).

Surgical Technique
A wide mastoidectomy with decompression of the mastoid tip, middle fossa dura, the sigmoid sinus, 2 to 3 cm of posterior fossa dura, and the jugular bulb was performed. All 8 specimens were well pneumatized. We then identified and “blue-lined” the posterior semicircular canal. We transected the endolymphatic duct at the operculum and then continued medially along the posterior semicircular canal. We transected the endolymphatic duct at the operculum and then continued medially along the posterior fossa dura until we reached the porus of the IAC. After exposure of the medial IAC with...
microscopic guidance, we transitioned to endoscopic-assisted drilling with the 30° endoscope to “blue-line” the vestibule medial to the posterior semicircular canal and then exposed the lateral extent of the IAC to the fundus. For much of the drilling, we used a 2-mm cutting bur and then a 2-mm diamond bur; we also found the 4-mm diamond’s radius helpful to increase the reach of the bur edge from the axis of the drill shaft. We did not use an endoscope holder. We spent time shuffling among the 3 separate instruments: endoscope, suction irrigator, and drill; hence, the efficiency of the endoscopic drilling portion of the procedure has the potential to be improved upon.

We incised the length of the dura to expose the contents of the IAC. We placed a ruler in the empty IAC and then measured from the fundus to a line between the superior and inferior limits of the IAC at the porus. Then, we used the microscope and each endoscope to measure the length that could be visualized with each.

**Results**

We were able to expose the entire length of the IAC in each of the 8 temporal bone specimens that underwent endoscopically assisted drilling through the presigmoid retrolabyrinthine approach. In these specimens, the range of the length of the IAC was 9.5 to 12 mm. In each specimen, the 0°, 30°, 45°, and 70° endoscopes afforded a view of the entire length of the IAC from porus to fundus (Table 1).

**Discussion**

In all specimens, the posterior semicircular canal obstructed the direct line-of-sight view of the fundus of the IAC through the microscope. Our measurements were made after decompressing 2 to 3 cm of retrosigmoid posterior fossa dura and slightly compressing the sigmoid sinus to facilitate a favorable angle for our instruments. In vivo, creating a small durotomy with release of cerebrospinal fluid (CSF) may aid in further retraction of the sigmoid sinus and posterior fossa dura to allow better fundal exposure and operative access to the IAC.

The 0° endoscope used in this project affords a field of view of 40° from the axis of the endoscope in every direction, which proved to be an adequate angle to visualize the fundus of the internal auditory canal.

The presigmoid retrolabyrinthine approach has been successfully used in the operative theater. Iacoangeli et al⁶ used the presigmoid retrolabyrinthine approach on patients with medium to large vestibular schwannomas. In this series, the IAC was not exposed, and patients did not undergo endoscopically assisted drilling.

Bento et al⁷ published a series of 22 patients with good hearing and small vestibular schwannomas that were resected by the presigmoid retrolabyrinthine approach with good facial nerve and hearing preservation results. In this study, the authors drilled the IAC under microscopic view. This modification of the presigmoid retrolabyrinthine

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**Table 1. Length of Internal Auditory Canal (IAC) and Percentage of IAC Visible.**

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Laterality</th>
<th>IAC Length, mm</th>
<th>mm (%) Visible with Microscope</th>
<th>mm (%) Visible with 0° Endoscope</th>
<th>mm (%) Visible with 30° Endoscope</th>
<th>mm (%) Visible with 45° Endoscope</th>
<th>mm (%) Visible with 70° Endoscope</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Left</td>
<td>11</td>
<td>8 (73)</td>
<td>11 (100)</td>
<td>11 (100)</td>
<td>11 (100)</td>
<td>11 (100)</td>
<td>11 (100)</td>
</tr>
<tr>
<td>Right</td>
<td>11</td>
<td>7.5 (68)</td>
<td>11 (100)</td>
<td>11 (100)</td>
<td>11 (100)</td>
<td>11 (100)</td>
<td>11 (100)</td>
</tr>
<tr>
<td>2 Left</td>
<td>11</td>
<td>9.5 (86)</td>
<td>9.5 (100)</td>
<td>9.5 (100)</td>
<td>9.5 (100)</td>
<td>9.5 (100)</td>
<td>9.5 (100)</td>
</tr>
<tr>
<td>Right</td>
<td>11</td>
<td>10 (91)</td>
<td>11 (100)</td>
<td>11 (100)</td>
<td>11 (100)</td>
<td>11 (100)</td>
<td>11 (100)</td>
</tr>
<tr>
<td>3 Left</td>
<td>9.5</td>
<td>8 (84)</td>
<td>8.5 (89)</td>
<td>9.5 (100)</td>
<td>9.5 (100)</td>
<td>9.5 (100)</td>
<td>9.5 (100)</td>
</tr>
<tr>
<td>Right</td>
<td>9.5</td>
<td>10 (83)</td>
<td>12 (100)</td>
<td>12 (100)</td>
<td>12 (100)</td>
<td>12 (100)</td>
<td>12 (100)</td>
</tr>
<tr>
<td>4 Left</td>
<td>11</td>
<td>10 (91)</td>
<td>11 (100)</td>
<td>11 (100)</td>
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<tr>
<td>Right</td>
<td>11</td>
<td>10 (91)</td>
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</table>
approach was termed the “widened retrolabyrinthine approach” by Darrouzet et al., then more thoroughly described in a series of 60 vestibular schwannomas and then again for epidermoid cysts. The method by Darrouzet et al includes drilling under microscopic view to expose the IAC, and they state that it is rarely possible to visualize directly more than two-thirds of the lateral wall of the IAC using this approach. We were able to improve the degree of IAC visualization with the microscope to greater than the 83% achieved by microscope alone by using endoscopically assisted drilling. Endoscopically assisted drilling provides visualization of the vestibule medial to the posterior canal and more thorough ability to blue-line this structure, thereby providing an improved view laterally.

A similar presigmoid retrolabyrinthine cadaveric study was performed by a Brazilian group who found that the 70° endoscope allowed for full view of the fundus of the IAC in 67.5% of specimens, the 30° endoscope allowed for full view of the fundus of the IAC in only 12.5% of specimens, and the 0° endoscope and microscope did not allow for visualization of the fundus. The difference in results between their study and ours may be explained by the addition of endoscopically assisted drilling in our study.

An intrinsic limitation of our project was the use of cadaveric heads. We did not have to consider the impact of using sigmoid sinus or cerebellum as a fulcrum or risks of cerebellar retraction.

Endoscopically assisted drilling through the presigmoid retrolabyrinthine approach can expose the entire IAC, and the resultant exposure is better visualized with endoscopes than with the microscope.

Figure 2. View from lateral medial to lateral when the tip of the 70° scope is placed at the porus of the IAC. FND, fundus; IAC, internal auditory canal; MFD, middle fossa dura; ST, superior trough.

Author Contributions
Thomas Muelleman, conception, design, acquisition, analysis, draft, editing, approval; Matthew Shew, design, acquisition, analysis, draft, editing, approval; Sameer Alvi, design, acquisition, analysis, draft, editing, approval; Kushal Shah, acquisition, analysis, draft, editing, approval; Hinrich Staecker, conception, design, analysis, draft, editing, approval; Roukouz Chamoun, conception, design, acquisition, analysis, draft, editing, approval; James Lin, conception, design, analysis, draft, editing, approval.

Disclosures
Competing interests: None.
Sponsorships: None.
Funding source: None.

References