Two-handed endoscopic-directed vestibular nerve sectioning: case series and review of the literature

Clinical article

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Object. Vestibular nerve sectioning is an accepted surgical treatment option for patients with medically refractory Ménière disease. In this paper the authors introduce and evaluate a 2-handed endoscopic-directed technique for vestibular nerve section.

Methods. Eleven patients underwent a retrosigmoid craniectomy for endoscopic-directed vestibular nerve sectioning as treatment for intractable vertigo associated with Ménière disease. In all patients, identification and dissection of the cranial nerve VII/VIII complex was performed entirely under endoscopic guidance. The authors used the specially designed Frazee II neuroendoscope, consisting of a traditional endoscope lens with a microsuction attachment.

Results. Vestibular nerve sectioning was completed in all 11 patients. Postoperative improvement in vertiginous episodes was achieved in 10 patients (91%). Auditory function was noted to be worse postoperatively in only 1 patient (9%). The same patient also developed a House-Brackmann Grade III facial nerve palsy, which improved gradually over time. There were no further complications, including no delayed CSF leaks.

Conclusions. The endoscopic-directed approach represents a safe and effective method for performing vestibular nerve sectioning. Until now, the endoscope has been used primarily as an adjunct to the operating microscope in surgery at the cerebellopontine angle. In addition, previous endoscopic techniques typically require a third hand to manipulate the endoscope. With the 2-handed endoscopic-directed technique, however, the endoscope is used as the primary means of visualization, and the unique design of this endoscope allows for a bimanual procedure without the requirement of a cosurgeon. Advantages of using this technique compared with the microscope include superior brightness at close distances, greater depth of field, increased maneuverability within small regions, and an improved ability to visualize objects not in a direct line of sight. Among other things, this allows for minimally invasive openings, decreased cerebellar retraction, and better identification of nerve cleavage planes and vascular anatomy.

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Key Words • endoscopy • Ménière disease • skull base • minimally invasive surgery • retrosigmoid approach • vestibular nerve sectioning

MÉNIEŘE disease, typically presenting in middle-aged adults, is characterized by symptoms of fluctuating low-frequency sensorineural hearing loss, intermittent episodes of vertigo, aural fullness, and tinnitus. The symptoms are believed to occur from the development of “endolymphatic hydrops,” or increased pressure and volume within the endolymphatic spaces. Initial treatment for Ménière disease involves medical therapy, followed by endolymphatic sac decompression or endolymphatic-subarachnoid shunt placement.

In patients whose symptoms prove refractory to these lower-risk treatment options, surgical selective vestibular nerve sectioning/neurectomy is a safe and effective hearing preservation surgery for treatment of the disabling vertigo associated with intractable Ménière disease. The procedure, which involves accessing the CPA, visualizing cranial nerve VIII, and sectioning the vestibular portion of the nerve on the affected side, has a reported symptomatic control rate between 82% and 95%, although it does not alter the natural course of the disease.

As with other pathologies at the CPA, a variety of surgical approaches for vestibular nerve section surgery have

Abbreviations used in this paper: CPA = cerebellopontine angle; IAC = internal acoustic canal.
been introduced and modified over the years. In particular, advantages in technology have produced instruments and techniques that have allowed for a more minimally invasive approach to lesions at the CPA. Specifically, with the advent of the modern neuroendoscope utilizing a rigid rod-lens system, considerable progress has been made using endoscopic surgical techniques in regions of the brain, both inside and outside the ventricular system. In comparison with the microscope, endoscopes allow for superior illumination of the operative field at close distances, greater depth of field, increased maneuverability in small regions such as the CPA, and improved visualization of objects not in a direct line of sight. The endoscopic-assisted vestibular nerve sectioning procedure, in which the endoscope is used as a visualization adjunct to the microscope, has been well described previously. The traditional design of the rigid endoscopes in these studies—consisting of either a lens, light source, and working channel within which instruments may be introduced or else of a lens and light source only with instruments used in parallel—requires there be either a cosurgeon to hold the endoscope or that it be fixed to the operating table. In this report, we introduce a single-operator (2-handed) endoscopic-directed approach for vestibular nerve sectioning, with a novel modification to the traditional endoscope. In this modification, in addition to being used as the primary visualization tool, the endoscope also contains a microsuction instrument attachment. This attachment allows for a 2-handed (bimanual) operation performed by a primary surgeon only, without the requirement of an assistant or mechanical endoscope holder.

Methods

Patient Population

This series represents a consecutive cohort of 11 patients with intractable unilateral Ménière disease who underwent a retrosigmoid craniotomy for endoscopic-directed vestibular nerve sectioning at UCLA Medical Center between 2005 and 2011. All patients underwent preoperative and postoperative audiometric evaluation and electronystagmography. Minimal follow-up duration was 3 months. The study was approved by our university institutional review board.

Endoscopic Instrumentation

We used the Frazee II Advanced Neuroendoscope (Karl Storz), which combines a 4-mm diameter rod-lens scope, light source, and camera into 1 lightweight instrument. Variable-size suction tips (5–12-Fr) are attached to the scope by a cam lock system, allowing the endoscope to be simultaneously used as a microsurgical suction instrument in addition to a visualization tool (Figs. 1 and 2). The working distance between the microsuction tip and endoscope lens is not fixed and may be easily lengthened or shortened at any time during the procedure. The distance ranges from 0.4 cm to 1.3 cm of extension from the lens (Fig. 3). Total diameter of the endoscopic lens with its microsuction attachment is 6.28 mm for the smallest suction tip and 7.73 mm for the largest tip. The entire visualization tool including lens, microsuction tool, and camera attachment weighs a total of only 190 grams.

Operative Technique

All operations were performed by the senior authors (J.G.F. and A.I.). The patient was first positioned supine on
the operating room table with the ipsilateral side slightly elevated by a rolled-up sheet. The head was placed in the Mayfield 3-point head holder and turned was the contralateral side before being secured to the table attachment. Care must be taken to turn the head sufficiently to bring the retromastoid region comfortably into view without compromising venous outflow. Increasing the amount of elevation of the ipsilateral side will reduce the degree of head turn that is necessary. All patients were evaluated prior to surgery to assess the amount of neck turning they could tolerate. Patients were secured with an anti-roll system to allow for bed manipulation, when needed, throughout the procedure. Intraoperative somatosensory evoked potentials, electroencephalography, and brainstem auditory evoked responses were used for continuous neurological function monitoring throughout the procedure.

Once a patient had been positioned, a curvilinear incision was made approximately 1 cm behind the base of the ear and carried down to the bone. Using the high-speed drill with acorn attachment, a 1.5- × 2.0-cm craniectomy was created, having made sure to visualize the transverse-sigmoid sinus junction at the anterior superior edge. The dura was then opened in a curvilinear fashion and retracted anteriorly. It was at this juncture that the 0° Frazee II neuroendoscope was introduced. Under endoscopic visualization, the arachnoid mater of the cisterna magna was identified and opened sharply to allow for the release of CSF and increased relaxation of the cerebellar hemisphere. A strip of telfa was placed over the cerebellum for protection throughout the remainder of the procedure. Along with preoperative mannitol and hyperventilation, opening the cisterna magna typically provides enough brain relaxation that retractors are not required. With the endoscope we were then able to visualize easily all the cranial nerves from IV through XI. Under endoscopic visualization, the cranial nerve VII/VIII complex was identified and dissected free of the arachnoid mater (Fig. 4). Nerve stimulation was then performed to identify specifically the facial nerve component. Once this procedure had taken place, the vestibular portion of cranial nerve VIII was visualized and selective vestibular nerve sectioning was performed by the otolaryngologist under endoscopic visualization. The technique involves cutting the vestibular nerve and separating the cut ends by stroking the fibers backward along the remaining intact portion of the nerve (Fig. 5). This step prevents any potential future reconnection of the incised fibers.

The vestibular portion of cranial nerve VIII typically appears grayish as compared with the cochlear component. In addition, an arteriole can often be visualized running along the cleavage plane of the nerve. Auditory function with brainstem auditory evoked responses was continuously monitored throughout the sectioning procedure. Once complete, the facial nerve was again stimulated to ensure its integrity. A watertight closure of the dura was then performed with running locking 4-0 nylon sutures followed by dural sealant glue. The bone was left off and the muscle and skin were approximated in multiple layers. Of note, the endoscope lens was cleaned when necessary during the procedure, simply by irrigating down the shaft of the scope with saline. Because the irrigation will
run over the lens surface before being suctioned away, this is usually sufficient for adequate cleansing. In only rare circumstances, therefore, will the endoscope have to be removed from the operative field.

Results

The patients included 6 men and 5 women, with a mean age of 47.7 years (range 25–77 years; Table 1). Average postoperative hospital stay was 4 days (range 2–8 days). All patients underwent a retrosigmoid approach, with primary use of the 0° and 30° endoscope to identify and section the vestibular nerve. Early on in our experience, with 5 patients, we opted for brief use of the operating microscope during the nerve-sectioning portion of the procedure. This served as an intermediate step in our learning curve before we became absolutely comfortable utilizing the endoscope for the entire operation.

In all subsequent cases, nerve sectioning was completed under endoscopic visualization. Partial or complete improvement in vertigo symptoms was achieved in 10 patients (91%). Auditory function as determined by audiometry was noted to be worse postoperatively in only 1 patient (9%). The same patient also developed a House-Brackmann Grade III facial nerve palsy, which improved gradually over time. There were no further complications, and no patient returned with a delayed CSF leak. Table 1 summarizes our clinical case series to date.

Discussion

Vestibular input to the CNS is normally bilateral and symmetrical.12,25,34 Symptoms of vertigo typically develop when vestibular disease on 1 side causes this input to become asymmetrical. The rationale for ablating the peripheral vestibular system, therefore, is to completely eliminate the abnormal vestibular input from the diseased side. The brainstem will, in turn, centrally compensate for this loss when it begins to receive normal vestibular signals from the unaffected side only. This should allow for near complete resolution of a patient’s vestibular symptoms in Ménière disease.12,34

In the 1930s, McKenzie and Dandy16 introduced the concept of sectioning only the vestibular portion of cranial nerve VIII via a suboccipital craniectomy to treat symptoms of intractable vertigo in patients with medically refractory Ménière disease. In 1961, House13 described the middle cranial fossa approach to the IAC for vestibular nerve sectioning. The technique was later modified by Fisch and Glasscock.8,11,13,25,27 This approach allowed for sectioning of both the superior and inferior vestibular nerves with good symptomatic control of vertigo but was complicated by high rates of facial nerve paralysis and deafness.7,22,24,25 Silverstein and Norrel30 subsequently described the retrolabyrinthine approach for vestibular nerve sectioning. This approach allowed for excellent visualization of the cranial nerve VIII complex in the CPA with minimal retraction of the cerebellum.18 There was, however, limited visualization of cranial nerve VIII in the lateral aspect of the IAC, making it difficult to determine a distinct separation between the vestibular and cochlear components when a poor cleavage plane existed.9,18,29 In addition, a CSF leak rate of approximately 10% was reported.2,25,29 In 1985, Silverstein and others29,31 modified their technique, adopting a purely retrolabyrinthine approach to the CPA for performing vestibular nerve sectioning. They reported experiencing a more complete exposure of the medial portion of the IAC with improved visualization of the cleavage plane of cranial nerve VIII.17,23,29,31 The incidence of CSF leak was also significantly reduced.2,29 Disadvantages of this technique included the presence of severe postoperative headaches when the bone over the IAC required drilling, as well as the need for increased retraction of the cerebellum as compared with the retrolabyrinthine approach.10,14,29 In 1987, Silverstein et al.29 introduced the combined retrolabyrinthine-retrosigmoid approach, which reduced the amount of cerebellar retraction required while eliminating the need for drilling of the IAC. Complete control of vertiginous symptoms was achieved in 85% of patients, with a hearing preservation rate of more than 80%.29,31
endoscopy as an adjunct to the microscope in 8 patients with unilateral Ménière disease. They observed through a retrolabyrinthine approach, in 2 cadavers and in 3 patients with unilateral Ménière disease. Prior to 1996, all operations at the CPA, including vestibular nerve sectioning, were performed under microscopic visualization only. With new advances in neuroendoscopic optics and miniaturization, however, Ozluoglu and Akbasak became the first to use video-assisted endoscopic visualization of the IAC for vestibular nerve sectioning through a retrolabyrinthine approach, in 2 cadavers and in 2 patients with unilateral Ménière disease. They observed that utilization of the 30° and 70° angled endoscopes offered an excellent view of the lateral portion of the IAC, eliminating the need for further drilling. With less removal of bone required, the risk of entering the semicircular canals or puncturing the jugular bulb was reduced, as was the reported incidence of postoperative headaches.

King et al.15 examined the utility and safety of rigid endoscopy as an adjunct to the microscope in 8 patients who underwent vestibular nerve sectioning via a retrosigmoid approach for treatment of unilateral Ménière disease. A 0° or 30° rigid endoscope was used in conjunction with the microscope for all patients. Complete vestibular nerve sectioning was achieved in all 8 patients, as confirmed by postoperative electronystagmography. Endoscopy allowed for improved visualization of the nerves intermedia, facial, cochlear, and vestibular nerves, as well as adjacent vascular branches, with only minimal cerebellar retraction required. In 3 of 8 patients, the cleavage plane between the vestibular and cochlear divisions of cranial nerve VIII could not be visualized with the microscope or the 0° endoscope. The cleavage planes of all 8 patients, however, were adequately identified with the 30° endoscope. These authors also described an enhanced ability to visualize the IAC and any exposed mastoid air cells, which, once identified, could be appropriately sealed, thereby reducing the incidence of postoperative CSF leak.15

Miyazaki et al.19 performed an endoscopic-assisted retrosigmoid approach utilizing the 30° angled endoscope in 345 patients with refractory unilateral Ménière disease. Use of the 30° endoscope allowed for complete inspection of the anterior surface of the cranial nerve VII/VIII complex and thus improved visualization of the facial nerve component. These investigators reported a success rate of 96% in partial or complete relief of vertigo, with only 4% of cases complicated by a CSF leak. Wackym et al.36 used the endoscope for 14 patients with intractable unilateral Ménière disease who underwent retrosigmoid craniotomies for vestibular nerve sectioning. Elimination of recurrent episodes of vertigo was achieved in all 14 patients in the postoperative period. As compared with using the microscope, endoscopy provided better visualization of neurovascular structures in the CPA without the need for significant retraction of the cerebellum. Mostafa et al.21 described excellent results as well in 28 patients who underwent vestibular nerve sectioning via a 2-cm² keyhole retrosigmoid craniotomy. The majority of the operations were performed as endoscopic-directed procedures in which the

### TABLE 1: Summary of patients with Ménière disease who underwent an endoscopic-directed vestibular nerve section procedure using the Frazee II neuroendoscope

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Procedure</th>
<th>Vertiginous Symptoms</th>
<th>Postop Hearing Status</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>54, M</td>
<td>endoscopic-directed/microscopic-assisted</td>
<td>improved</td>
<td>unchanged</td>
<td>none</td>
</tr>
<tr>
<td>2</td>
<td>53, F</td>
<td>endoscopic-directed/microscopic-assisted</td>
<td>improved</td>
<td>unchanged</td>
<td>none</td>
</tr>
<tr>
<td>3</td>
<td>53, F</td>
<td>endoscopic-directed</td>
<td>improved</td>
<td>unchanged</td>
<td>none</td>
</tr>
<tr>
<td>4</td>
<td>38, F</td>
<td>endoscopic-directed/microscopic-assisted</td>
<td>unchanged</td>
<td>unchanged</td>
<td>none</td>
</tr>
<tr>
<td>5</td>
<td>25, F</td>
<td>endoscopic-directed/microscopic-assisted</td>
<td>improved</td>
<td>unchanged</td>
<td>none</td>
</tr>
<tr>
<td>6</td>
<td>77, M</td>
<td>endoscopic-directed</td>
<td>improved</td>
<td>unchanged</td>
<td>none</td>
</tr>
<tr>
<td>7</td>
<td>56, M</td>
<td>endoscopic-directed</td>
<td>improved</td>
<td>unchanged</td>
<td>none</td>
</tr>
<tr>
<td>8</td>
<td>50, F</td>
<td>endoscopic-directed/microscopic-assisted</td>
<td>improved</td>
<td>decreased from baseline</td>
<td>House-Brackmann Grade III facial nerve palsy</td>
</tr>
<tr>
<td>9</td>
<td>57, M</td>
<td>endoscopic-directed</td>
<td>improved</td>
<td>unchanged</td>
<td>none</td>
</tr>
<tr>
<td>10</td>
<td>34, M</td>
<td>endoscopic-directed</td>
<td>improved</td>
<td>unchanged</td>
<td>none</td>
</tr>
<tr>
<td>11</td>
<td>28, M</td>
<td>endoscopic-directed</td>
<td>improved</td>
<td>unchanged</td>
<td>none</td>
</tr>
</tbody>
</table>
endoscope was used almost exclusively for visualization and sectioning of the vestibular nerve. In all previous descriptions of endoscopic surgery at the CPA, the design of the endoscope required that a 3-handed technique be used. An assistant had to be present to manipulate the endoscope or the endoscope had to be fixed to a table attachment in order for the primary operating surgeon to have both hands free. In the past this requirement of three hands has often been cited as one of the main drawbacks to endoscopic surgery. The Frazee II neuroendoscope, by comparison, eliminates this problem by combining a microsuction attachment, lens, and light source into 1 lightweight and easy-to-maneuver instrument. This changes the operation to a 2-handed procedure, reducing the amount of cerebellar retraction required because only 2 instruments are now present within the operating field at any given time. Furthermore, the procedure with the Frazee II neuroendoscope may be performed entirely by the operating surgeon without the requirement of an assistant or a mechanical endoscope holder. With the unique design of this endoscope the surgeon has the visualization source and microsuction in 1 hand, allowing the second hand to remain free for the manipulation of a dissecting instrument or the microscissors when such is necessary for nerve sectioning. In this way, an endoscopic vestibular nerve section performed with the Frazee II neuroendoscope has the visualization advantages of endoscopy while maintaining conventional bimanual microsurgical operative techniques.

A second unique feature of the Frazee II neuroendoscope is the mobility of the microsuction tip in relation to the lens/light source. Instead of facing the limitation of a fixed working distance, the length of the microsuction instrument may be adjusted at any time during the procedure. Placing the microsuction tip closer to the edge of the endoscope lens allows one to move farther into the operative field without fear of a suction-induced neurovascular injury. Thus, a more detailed inspection of cranial nerves VII and VIII may be performed before proceeding with the vestibular nerve sectioning. Given that excessive cerebellar retraction and neurovascular manipulation are the most common causes of serious morbidity associated with the vestibular nerve sectioning procedure, we believe that eliminating the problem of a “third hand” within the operative field represents an improvement over traditional endoscopy and will result in better all-around surgical results.

We performed 11 endoscopic-directed vestibular nerve sectionings for intractable Ménière disease using the Frazee II neuroendoscope. Our success rate of 91% symptomatic control of vertigo compares favorably with previously published reports on vestibular nerve section surgery. In addition, with only 1 patient experiencing postoperative hearing loss, our technique has demonstrated an acceptably low complication rate. Although the primary goal in each procedure was to use the endoscope as our only means of visualization, in 5 cases early in our experience we chose to use the operating microscope briefly when sectioning the vestibular nerve. The process we went through in becoming comfortable with a fully endoscopic procedure highlights one of the main limitations to an endoscopic-directed approach. Unlike with the operating microscope, endoscopy allows for visualization of only what is directly in front of the lens. As a result, one must be cognizant at all times of structures that are near the endoscope shaft but not within view, especially while moving in and out of the operative field. This is especially important in a region such as the CPA, which contains neurovascular structures in close proximity to one another, and in a procedure such as a vestibular nerve section, in which prior to performing the vestibular nerve sectioning the endoscope must be used to look around cranial nerve VIII to confirm the location of and to stimulate cranial nerve VII. With the operative advantages provided by the unique design of the Frazee II neuroendoscope, however, we were able to accelerate our learning curve while also, we believe, improving the safety and effectiveness of the endoscopic-directed approach at the CPA. Ultimately, it is our expectation that the future of endoscopic visualization will be with microchips at the end of flexible instruments, allowing for the ability to obtain a panoramic view in all directions without having to manipulate the endoscope shaft. Among other things, this will allow for the passage in and out of keyhole surgical openings through safer corridors.

Another common critique of endoscopic surgery is that, unlike with the microscope, visualization occurs only in 2 dimensions. There is the belief that this diminishes our ability to understand the relationship of structures, which are at varying depths within the operative field. In fact, the increased maneuverability of the Frazee II neuroendoscope allows one to move in and out of the operative field with relative ease. The combination of this feature, along with an ability to obtain a much more detailed view of structures up close without experiencing any decrease in light intensity, virtually eliminates any of the perceived deficiencies associated with viewing in 2 dimensions. Furthermore, significant progress has been made recently with endoscopic visualization in 3 dimensions, especially in endoscopic transsphenoidal surgery. We have yet to incorporate this technology into our practice but would be open to utilizing it in future cases.

**Conclusions**

The single-operator (2-handed) endoscopic-directed approach is a safe and effective technique for performing vestibular nerve sectioning at the CPA. This approach represents the latest modification to what has become an acceptable surgical treatment option for patients with severe disabling vertigo brought on by Ménière disease. With the visualization advantages provided by the endoscope, along with the enhanced features of the Frazee II version, we have effectively used an endoscopic-directed approach in a variety of other procedures, both at the CPA and in other narrow corridors of the brain. These other procedures include microvascular decompressions, deep-seated tumor resections, and supraorbital aneurysm surgery. As has already been proven with vestibular nerve section surgery, it is our belief that greater acceptance and utilization of endoscopy will serve to reduce morbidity further, while significantly improving the results of these and other neurosurgical procedures. Future studies directly comparing endoscopy with traditional microneurosurgery will, however, be necessary.
Endoscopic-directed vestibular nerve section

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Ishiyama, Frazee. Acquisition of data: Cutler, Kaloostian, Frazee. Analysis and interpretation of data: Kaloostian, Frazee. Drafting the article: Cutler, Kaloostian. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Cutler. Study supervision: Ishiyama, Frazee.

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