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Original Article

Selective retromastoid vestibular neurectomy for intractable Ménière's disease: A technical note

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Abstract

Background: Retrosigmoid vestibular neurectomy is considered to be the most effective and safe procedure to control intractable vertigo associated with Ménière's disease while preserving hearing. The surgical procedure of retrosigmoid vestibular neurectomy at the cerebellopontine angle has been well established. Here, we provide for otologic surgeons additional details about the procedure, with special attention to the anatomic features to emphasize our technique, which enables an adequate sectioning of the vestibular fibers on the cochlear nerve close to the overlapping zone containing large-caliber vestibular fibers and small-caliber cochlear fibers.
Methods: We used the lateral decubitus position to enter the cerebellopontine angle. The cerebellum was gently retracted to expose the cerebellomedullary cistern, which was then opened to drain the cerebrospinal fluid for slacking of the cerebellum. The underlying lower cranial nerves IX, X, and XI were identified. The retractor was then moved upward to locate the internal acoustic meatus and the complexes VIII−VII. Adjacent to the internal auditory canal, a longitudinal incision, about 3 mm long and 0.5 mm away from the landmarks of arteriole or cochleovestibular cleavage plane, was made on the cochlear nerve. A surgical separation plane was bluntly created using a microdissector between the two components, and the vestibular nerve was sharply sectioned with microscissors.
Results: We re-examined the patients' hearing status, word recognition (speech discrimination) skill, functional levels, and frequency of vertiginous episodes 1 month and at all 6-month intervals after the surgery. At 2 years after surgery, vertigo was completely controlled, indicating a 100% cure rate.
Conclusion: Sectioning of vestibular fibers was performed along the cochleovestibular cleavage landmark on the cochlear nerve where the overlapping zone was located, allowing for a safe and adequate vestibular neurectomy, while most of the cochlear fibers were spared.

Keywords: cochleovestibular cleavage plane; overlapping zone; retrosigmoid; vestibular neurectomy

1. Introduction

There are a number of surgical procedures, mostly performed by otologic surgeons, for controlling the intractable vertigo associated with Ménière's disease (MD). However, these procedures can result in variable degrees of hearing impairment. Retrosigmoid vestibular neurectomy, a procedure with a high rate of hearing preservation, has emerged as one of the most effective methods to control this disabling vertigo.[1−4]

As early as the 3rd decade of the past century, two outstanding neurosurgical ancestors, Walter Dandy and Kenneth McKenzie, performed several hundred vestibular neurectomies in MD patients using a posterior fossa suboccipital craniectomy to treat intractable vertigo.[5] Nevertheless, following Dandy's

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death, this surgical treatment does not seem to have gained wide publicity in the neurosurgical community. This suboccipital retrosigmoid selective vestibular neurectomy is clearly a neurosurgical procedure that allows for a safe and easy approach and more complete transection of the vestibular fibers. The retrosigmoid approach is indeed almost the same surgical technique as the suboccipital approach, with a smaller craniectomy. The technique has now achieved broader acceptance.

We aim to share the stepwise technical skills used by our interdisciplinary team of otologists and neurosurgeons with the surgeons in training in the otological and neurosurgical communities.

2. Methods

2.1. Demographic data of patients

Each year, approximately 100 new patients are diagnosed with classic MD in Kuang-Tein General Hospital, Taichung, Taiwan. Less than 10% of the overall MD patients undergo selective vestibular neurectomy every year. A total of 102 patients (48 men and 54 women; mean age, 51.4 years; age range, 25–77 years) with intractable MD were operated on during a 16-year period from April 1995 to May 2011. The duration between the onset of vertigo and the date of surgery varied from 12 months to 14 years (mean 6.1 years). The frequency of vertiginous episodes was 0.5–6 times per month 6 months prior to surgery, and the left side was affected more often (64%) than the right side.

2.2. Surgical indications and preoperative workup

All patients were selected by the same neuro-otologist because they experienced incapacitating vertigo, dizziness, or drop attacks that had not responded to other therapies. Their functional level of disability varied from 4 to 6 points (Table 1) according to the guidelines of the 1995 American Academy of Otolaryngology—Head and Neck Surgery Committee on Hearing and Equilibrium for the diagnosis and evaluation of therapy in MD[6]; they either were unable to work at the time of their surgery or had severe limitations in terms of routine daily activities.

Preoperative evaluation consists of a 4-frequency pure-tone average and speech discrimination score, tympanometry, electronystagmography, and enhanced magnetic resonance imaging of the brain focused on the ipsilateral posterior fossa to exclude any gross anatomic pathologies, such as tumors or vascular lesions. According to the staging system of the American Academy of Otolaryngology—Head and Neck Surgery using pure-tone audiometry, 69 (68%) patients had stage-3 hearing function and 19 (18%) stage-4 hearing function (Table 2).

2.3. Relevant surgical anatomy and description of the technique

All the surgeries were performed by the same neurosurgeon (C.-S.L.). The mastoid process and the tip were identified by palpation as the surface landmarks (Fig. 1). A burr hole was made just below the mastoid foramen and posterior to the incisura mastoidea. The bony opening was rongeured anteriorly to the posterior margin of the sigmoid sinus and inferiorly to the upper margin of the condylar fossa.

A cruciate dural incision was made close to the sigmoid sinus, and the dura was sutured back out of the way. The cerebellum was gently retracted at the condylar fossa to expose the cerebellomedullary cistern. Once the cerebellum was slackened, the underlying lower cranial nerves IX, X, and XI can be identified. The retractor was then moved rostrally to locate the complex of cranial nerves VIII and VII near the internal auditory canal. The arachnoid membrane covering the cochleovestibular nerve was carefully dissected to expose the nerve complex. All the vessels around the nerve, especially the labyrinthine artery, had to be carefully handled and preserved.

Table 1
Functional Disability Scale (AAO-HNS, 1995 reporting criteria).

Check the ONE statement that best applies to your current state of overall function (not just during attacks)
1. My dizziness has no effect on my activities at all.
2. When I am dizzy, I have to stop what I am doing for a while, but it soon passes and I can resume my activities. I continue to work, drive, and engage in any activity I choose without restriction. I have not changed any plans or activities to accommodate my dizziness.
3. When I am dizzy, I have to stop what I am doing for a while, but it passes and I can resume activities. I continue to work, drive, and engage in most activities I choose, but I have had to change some plans and make some allowance for my dizziness.
4. I am able to work, drive, travel, take care of a family, or engage in most essential activities, but I must exert a great deal of effort to do so. I must constantly make adjustments in my activities and budget my energies. I am barely making it.
5. I am unable to work, drive, or take care of a family. I am unable to do most of the active things that I used to do. Even essential activities must be limited. I am disabled.
6. I have been disabled for 1 year or longer and/or I receive compensation (money) because of my dizziness or balance problem.

Note. From "Committee on Hearing and Equilibrium Guidelines for the Diagnosis and Evaluation of Therapy in Ménière's Disease" by American Academy of Otolaryngology-Head and Neck Foundation, Inc., 1995, *Otolaryngol Head Neck Surg*, *113*, p. 181–5. Copyright: 1995, AAO-HNS. Reproduced with permission.
AAO-HNS = American Academy of Otolaryngology—Head and Neck Surgery.

Table 2
Staging of preoperative hearing function in 102 patients (AAO-HNS, 1995 reporting criteria).[a]

Stage	4-tone mean (dB)	No. (%) of patients
1	<25	5 (5)
2	26–40	9 (9)
3	41–70	69 (68)
4	>70–<80	19 (18)

AAO-HNS = American Academy of Otolaryngology—Head and Neck Surgery.
[a] Staging is based on the 4-tone average of the pure-tone thresholds at 0.5 kHz, 1 kHz, 2 kHz, and 3 kHz from the worst audiogram in the 6 months prior to treatment.

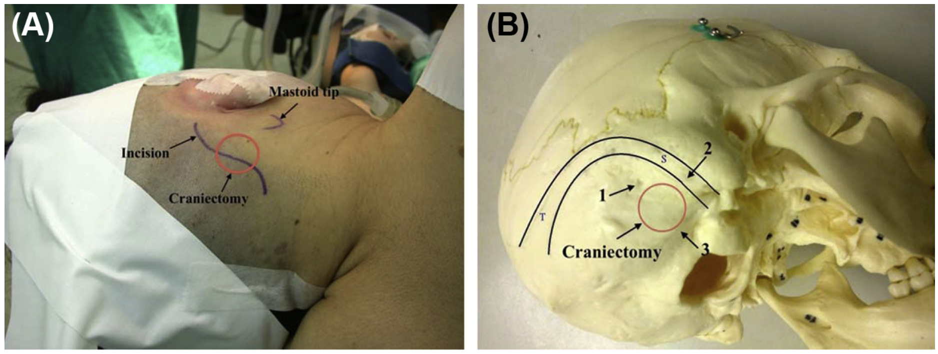

Fig. 1. After general anesthesia, the patient was put in the lateral decubitus position with the vertex dropped 15° toward the floor. (A) Anatomic landmarks and the site of incision and craniectomy. (B) Anatomic landmarks on the cranium. The mastoid foramen (1), which conveys the mastoid emissary vein, indicates the posterior margin of the middle portion of the sigmoid sinus (s). The posterior end of the incisura mastoidea (2) grossly corresponds to the level of the internal acoustic meatus. The bony opening should be made below the mastoid foramen, posterior to the incisura mastoidea and superior to the edge of the condylar fossa (3).

Upon careful inspection of the cranial nerve VIII, we usually observed a difference in color between the superior half (the vestibular nerve being relatively gray) and the inferior half (the cochlear nerve being relatively white), which sometimes helped in demarcating the two components. In almost all cases, a fine vessel (arteriole) courses along the demarcation line between the vestibular and cochlear components. In most cases, a fine septum or mild invagination was noted along the surface of the cranial nerve VIII, creating a cochleovestibular cleavage plane (Fig. 2). There was an overlapping zone containing large-caliber vestibular fibers and small-caliber cochlear fibers located within the cochlear subdivision adjacent to the cochleovestibular cleavage plane, with a measured width of 0.22–0.55 mm in the superior–inferior direction.[7] Adjacent to the internal auditory canal, a longitudinal incision, about 3 mm long and 0.5 mm away from the arteriole or cochleovestibular cleavage plane, was made on the cochlear nerve. A surgical separation plane was bluntly created using a microdissector between the two components, and the vestibular nerve was sharply sectioned with microscissors.

2.4. Surgical findings

During the operation, a fine arteriole was found on the surface of the cochleovestibular nerves in 92 (90%) of 102 patients. Prominent invaginations (cochleovestibular cleavage plane), alone or in combination with the arteriole, were found in 53 (52%) patients. Of the 13 patients who had already received endolymphatic sac surgery, eight had variable degrees of arachnoid adhesion around cranial nerve VIII; these patients had received an endolymphatic sac–subarachnoid shunt. Relatively few patients had postoperative complications.

2.5. Postoperative result

The control of vertigo was assessed using the 1995 American Academy of Otolaryngology—Head and Neck Surgery Committee on Hearing and Equilibrium classification.[6] The relative change in the number of vertiginous episodes before and after vestibular neurectomy was expressed as a ratio of these two values and assigned to Classes A–E (from excellent to worse), as shown in Table 3. At 2 years after surgery, vertigo was completely controlled, indicating a 100% cure rate. After ≥2 years of follow-up, there was a progressive decrease in Class A and a relative increase in Class B patients due to occasional mild spells of vertigo attacks, but there were no patients falling into Class C.

We re-examined the patients' hearing status, word recognition (speech discrimination) skill, functional levels, and frequency of vertiginous episodes 1 month and at all 6-month intervals after the surgery. Descriptive statistics were performed and expressed as the mean ± standard deviation and percentile to show the changes of frequencies of vertigo, hearing thresholds (in decibels), word recognition (in percentages), and functional levels (in points) against the baseline during the follow-up period (Table 4). A significant increase from baseline hearing thresholds (pure-tone average in decibels) was observed, with continual elevations during a 16-year follow-up (Table 4). The percentage of speech discrimination (standard deviation) coincided with increases in hearing thresholds and declined from baseline over the same period.

3. Discussion

3.1. Advantage of neurectomy at the overlapping zone

In the posterior fossa proximal to the porus acousticus, there is an overlapping zone containing large-caliber vestibular fibers and small-caliber cochlear fibers located within the cochlear subdivision adjacent to the cochleovestibular cleavage plane, with a measured width of 0.22–0.55 mm in the superior–inferior direction.[7] Owing to this intermingling of the vestibular and cochlear fibers adjacent to the plane of the macroscopic cleavage landmarks, it is not possible to accurately split the two subdivisions in a microscopic sense. In view of this topography of the cochleovestibular nerve fibers in the posterior fossa, we make a sharp surgical incision 0.5 mm aside from the landmarks (cochleovestibular cleavage

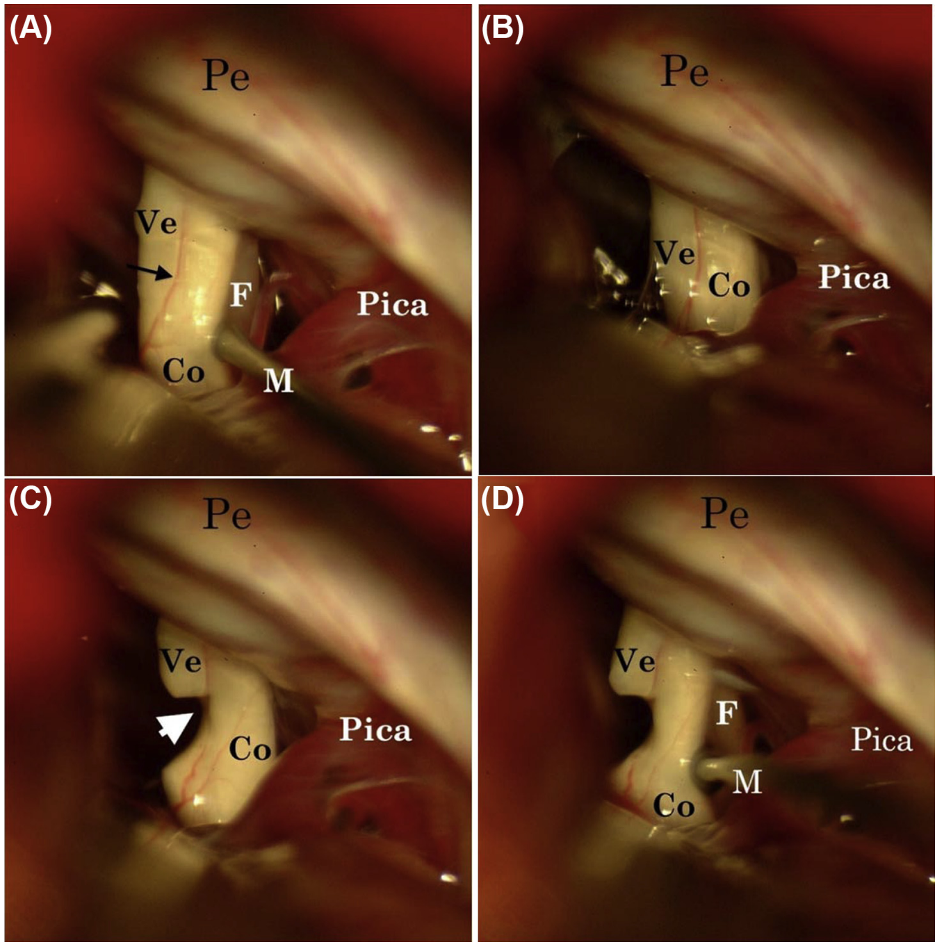

Fig. 2. Intraoperative photographs of a patient with right-sided Meniere's disease. (A) A fine arteriole (black arrow) ran along the demarcation space between the cochlear and vestibular nerves. Note the location of the underlying facial nerve. (B) The vestibular nerve was grayer in color than the cochlear nerve. (C) The overlapping zone (white arrowhead) located within the cochlear subdivision adjacent to the cochleovestibular cleavage plane was divided. (D) The intact facial nerve beneath the cochlear nerve. Co = cochlear nerve; F = facial nerve; M = microdissector; Pe = petrous ridge of temporal bone; Pica = posterior inferior cerebellar artery; Ve = vestibular nerve.

plane and arteriole) on the cochlear nerve to aid in complete sectioning of the vestibular fibers, while sparing most of the cochlear fibers. Modified sectioning of the mixed fibers on the cochlear nerve did not worsen hearing, as reported in this study. Furthermore, adequate resection of the vestibular fibers enhanced improvement of functional levels because patients were free from vertiginous episodes during follow-up. This was done to improve the completeness of sectioning of the vestibular fibers with minimal, if any, compromise of hearing function.

Table 3
Control of vertigo after 16 years of follow-up (modified AAO-HNS 1995 classification).

Class	Numerical value[a]	No. (%) of patients
A (excellent)	0	95 (93.1)
B (good)	1–40	7 (6.9)
C (fair)	41–80	0
D (poor)	81–120	0
E (worse)	>120	0
Total		102 (100)

AAO-HNS = American Academy of Otolaryngology—Head and Neck Surgery.

[a] Numerical value = $(X/Y)100$, rounded to the nearest whole number, where X is the average number of definitive episodes per month over 6 months after a 2-year postoperative follow-up and Y is the average number of definitive episodes per month in the 6 months prior to therapy.

3.2. Limitations

The small bony opening usually does not exceed 2 cm in diameter. However, in a large, muscular, and/or dolichocephalic patient, a longer skin incision and a bigger craniectomy should be made and placed more posteriorly to provide an appropriate angle for easy viewing through the operating microscope and draining of cerebrospinal fluid via the cerebellomedullary cistern.

3.3. How to avoid complications

In view of the general anatomical features of the mastoid bone and in our experience, the mastoid air cell is usually not encountered, but should it be opened, it must be waxed thoroughly to avoid postoperative cerebrospinal fluid rhinorrhea.

Table 4
Overall results during 16 years of follow-up (means and standard deviations) in 102 patients.

	Baseline	Postoperative follow-up				
		1 mo	1 y	3 y	5 y	16 y
Frequency of vertigo	3.29 ± 2.70	0.00 ± 0.00	0.00 ± 0.00	0.01 ± 0.07	0.03 ± 0.10	0.10 ± 0.05
Hearing thresholds (dB)	60.79 ± 16.30	61.63 ± 15.29	64.73 ± 18.08	67.84 ± 12.97	72.20 ± 12.70	77.45 ± 23.48
Word recognition (%)	63.04 ± 20.15	59.75 ± 19.66	55.72 ± 18.62	50.41 ± 14.28	50.45 ± 13.31	30.28 ± 13.45
Functional level (points)	4.55 ± 0.56	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	1.22 ± 0.14	1.76 ± 0.67

Sectioning of the vestibular nerve should be carried out with microscissors, beginning from the medial to the lateral aspect to avoid injury to the cochlear nerve and the underlying facial nerve.

At the end of the surgery, watertight dural closure in such a small opening is usually hampered by its retraction. Therefore, a piece of Neuro-patch (B. Braun, Aesculap, Tuttlingen, Germany) is sutured around the dural edges, which are then soaked with Histoacryl (B = Braun, Aesculap). A thick piece of Gelfoam (Pharmacia & Upjohn Company, Kalamazoo, MI, USA) is used to cover the craniectomy defect before the tissue glue dries. The fascia should be sutured in a watertight fashion to avoid leakage of the cerebrospinal fluid from the wound.

3.4. Postoperative course and instructions from the surgeon

The patient is monitored overnight in the neurosurgical intensive care unit. The blood pressure should be maintained in a normal range should the patient have hypertension. No osmotic agent should be used. Postoperative checks of the cranial nerve functions should be carried out, with particular attention to the facial and cochlear nerves. Should there be any profound headache or dizziness, steroid treatment should be used for 2 days. The patient is usually discharged after 5 days.

3.5. Instructions to the patient

The patient must be notified that this surgery cannot alter the natural course of MD progression; it only alleviates the vestibular vertigo. Immediate postoperative profound hearing impairment or even deafness, although rare, may occur. Immediate postoperative vestibular symptoms due to sudden deafferentation are anticipated and may last for 1−2 months before stabilization. The patient is followed-up regularly by the same neuro-otologist at the outpatient department.

In conclusion, in view of the topography of the cochleovestibular nerve fibers in the posterior fossa, we make a sharp surgical incision 0.5 mm to the side of the landmarks (cochleovestibular cleavage plane and arteriole) on the cochlear nerve to aid in complete sectioning of the vestibular fibers; most of the cochlear fibers are spared.

Retrosigmoid vestibular neurectomy is clearly a neurosurgical procedure with a safe and easy approach and allowing more complete transection of the vestibular fibers. All patients should have an accurate diagnosis of definite classic unilateral MD prior to surgery and at regular follow-up evaluations after the surgery, performed by the same neuro-otologist. The treatment of intractable vertigo in MD requires a framework of enthusiastic and close interdisciplinary collaboration between both neuro-otologists and neurosurgeons.

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