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Microvascular Decompression of the Eighth Nerve in Patients with Disabling Positional Vertigo: Selection Criteria and Operative Results in 207 Patients

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Summary

Two-hundred seven patients who were operated on consecutively between January 1983 and December 1990 to relieve disabling positional vertigo (DPV) using the microvascular decompression (MVD) procedure were studied. Selection of the patients for MVD operations was based on both case history and the results of oto-neurological tests. Of the 177 patients with unilateral symptoms, 8 were excluded because of previous vestibular nerve section, and 6 did not return for follow-up; of the remaining 163 patients, 129 (79%) were free of symptoms or markedly improved following MVD, and none became worse. Thirty patients had symptoms and signs of bilateral DPV, and of these 1 was excluded because of previous vestibular nerve section and 3 because of multiple operations. Of the remaining 26 patients, 20 (77%) were free of symptoms or markedly improved following MVD. Eleven of these patients had more than 2 operations. The follow-up time was an average of 38 months, ranging from 3 months to 10 years.

The cure rate (about 80%) of MVD for DPV is similar to that reported for MVD for trigeminal neuralgia and hemifacial spasm. The cure rate of MVD for DPV was not related to gender or to the duration of the symptoms.

Following a total of 254 operations that these 207 patients underwent, 4 patients (1.6%) lost hearing and 4 (1.6%) suffered marked hearing loss. Three patients suffered temporary deficits of other cranial nerves. There were no other complications to these operations.

Keywords: Disabling positional vertigo; microvascular decompression.

Introduction

It is a well established fact that vascular compression of cranial nerves in the cerebellopontine angle (CPA) can cause both hyperactivity and hypoactivity of the respective nerves[1, 6–8, 12, 19, 20]. The most well known of the disorders that are caused by vascular compression are trigeminal neuralgia (TN), hemifacial spasm (HFS), and glossopharyngeal neuralgia (GPN). Microvascular decompression (MVD) of the affected nerve has a high rate of cure: 81% for TN and 85% for HFS[19]. There is also evidence that rare disorders as spasmodic torticollis[5] and cyclic spasms of the oculomotor nerve[16] can be caused by vascular compression of a cranial nerve.

Recently, evidence has been presented that indicates that vascular compression of the eighth nerve may produce specific symptoms and signs in the auditory and the vestibular systems and that such symptoms can be alleviated by MVD. Thus it has been shown that certain forms of tinnitus can be relieved by vascular decompression of the cochlear portion of the eighth cranial nerve[9, 15, 26]. The success rate of MVD operations for tinnitus is not as high as it is for HFS and TN (40% for patients with severe tinnitus; 29% for men and 54% for women[3, 6]). Earlier we had shown that vascular compression of the vestibular portion of the eighth nerve can cause very specific symptoms of vertigo and/or disequilibrium and nausea[13, 14, 25], and we named the disease entity that is caused by vascular compression of the vestibular nerve, disabling positional vertigo (DPV)[13]. We have reported on the diagnosis of DPV and the results of treating this syndrome with MVD[21, 22]. Others presented similar results[27]. In the present paper we describe criteria for selecting patients with vestibular disorders for MVD operation, and we present pre-operative test results on 207 patients who were operated on for DPV using MVD of the eighth cranial nerve as well as the follow-up results of the procedure in 201 of these patients (we were unable to follow-up on 6 patients).

Criteria for Selection of Patients for MVD

The criteria for patient selection, which was consistent throughout the period covered by this study, has been described previously[25]. Differentiation between vascular compression and other causes of vestibular disturbance was done on the basis of the presence of one or more of several specific symptoms and signs as described below. The patient's symptoms are most important. The most sensitive test is the recording of brainstem auditory evoked potentials (BAEP), but audiometric and vestibular tests also provide valuable information. Correct determination of which side is affected is naturally of great importance when DPV is to be treated with MVD, but which side is affected is not directly obvious from the symptoms. Examination of symptoms from adjacent cranial nerves, detection of subtle abnormalities in the BAEP, and the patient's pure tone audiogram are useful when attempting to ascertain which side is affected.

Vestibular symptoms: A more-or-less constant sensation of true vertigo or a spinning sensation frequently associated with nausea is an important sign of DPV. A further sign is a sudden onset of severe vertigo, nausea, and vomiting. While these symptoms may resemble vestibular neuronitis, they do not improve after the administration of vestibular suppressant medications and fluids, and the patient fails to recover completely and experiences a more-or-less constant vertigo or spinning that over time increases in intensity, and associated with nausea of varying intensity it is a sign of DPV rather than vestibular neuronitis. Also, if the symptoms are worsened by commonly used vestibular suppressant medications such an Antivert, Dramamine, or Transderm Scop, while a low dosage of Valium or clonazepam gives some relief, then DPV is indicated.

Another important sign of DPV is that the symptoms and signs worsen with all physical activity and abate with complete bed rest. The patient becomes increasingly limited regarding activity and must cease working and driving and is unable to do even minimal household chores and becomes essentially confined to the house. Typically, the walk of a DPV patient becomes affected and their gait is often labeled ataxic. Maybe the most characteristic sign of DPV is that the patient walks like a drunken person, with the exception that he/she does not stagger all over but drifts constantly to one side – the affected side. The patients often summarize their symptoms as having had "one drink too many." Difficulty in making quick turns, staggering, and often falling towards the affected side are typical signs of DPV. Another typical symptom of patients with vascular compression of the vestibular nerve is vertigo in the forms of feeling a constant movement inside the head – like a pendulum swinging back and forth, the feeling of being on a boat, or the feeling that the floor is coming up and down when standing or walking. A further indication of DPV is that all these symptoms are worse when the head or body is in a certain position.

There are also distinct differences in the pattern of symptoms of patients with DPV compared to that of patients with vestibular disorders such as Meniere's disease and benign paroxysmal positional nystagmus (BPPN). While Meniere's disease is characterized by attacks of aural fullness, violent vertigo, tinnitus, and hearing loss lasting from 1 to 24 hours with the patient being asymptomatic between attacks, patients with DPV experience their symptoms more-or-less constantly. The vertigo of patients with BPPN is elicited when the head is in a certain position, with onset of nystagmus 4 to 5 seconds after positioning the head and associated with vertigo, and these symptoms decrease and abate upon repeated positioning. Also, BPPN patients are typically asymptomatic for long periods of time.

The symptoms of a perilymphatic fistula can sometimes resemble those of DPV, but the onset of the vertigo caused by a perilymphatic fistula usually occurs after middle ear pressure changes, such as when scuba diving or flying, while the sinuses are severely congested.

The symptoms of DPV are different from those of vestibular neuronitis or mononeuronitis of the vestibular nerve in that patients with vestibular neuronitis experience acute onset of severe vertigo associated with vegetative symptoms when moving the head and the response in one ear upon caloric stimulation is severely reduced or absent. Usually patients with vestibular neuronitis become totally symptom free after a few weeks to 6 months, depending on age at onset.

Symptoms and signs from the cochlear nerve: Signs and symptoms of irritation of the auditory nerve are important in identifying patients with DPV. We consider progressive sensorineural hearing loss on the affected side in the high-frequency range or flat hearing loss that does not fluctuate to be a sign of vascular compression of the eighth cranial nerve. A low-frequency upsloping hearing loss, similar to that noted in early stages of Meniere's disease, but with no fluctuation is also a sign of vascular compression, as are small

dips in the mid-frequency range in the pure tone audiogram. Earlier we had shown that such "dips" and low-frequency hearing losses occur in 23% of patients with HFS[24] as a result of irritation to the auditory nerve from a vessel - the cause of HFS. Minor differences in pure tone hearing threshold (that may not be noticed by the patient) between the affected side and the normal side is also a sign of vascular compression of the auditory nerve. Tinnitus, unilateral or bilateral, is also a sign of irritation of the auditory nerve.

Symptoms and signs from adjacent cranial nerves: When a blood vessel compresses the vestibular nerve it may also be in contact with other cranial nerves in the posterior fossa, and therefore specific signs from these other nerves may indicate a vascular compression of the vestibular nerve, and such signs may aid in determining which side is affected. For instance, deep, sharp, ear pain (geniculate neuralgia) that can be caused by irritation of the intermedius nerve, mild twitching of the orbicularis oculi muscle on one side that indicates irritation fo the facial nerve, and transient numbness or pain in one of the branches of the trigeminal nerve (usually the V 2 branch) are signs that support vascular compression being the cause of vestibular symptoms.

Patients whose symptoms and signs are indicative of DPV are informed about the MVD procedure, its complications (hearing loss, loss of hearing, facial paralysis, brainstem stroke, and death) as well as its success rate in treating DPV. Such patients are also informed that vertigo is not a terminal disease and that its treatment is a matter of quality of life. Naturally, elderly patients and patients with medical problems that may increase the risk of operative complications are excluded from undergoing MVD procedure.

Patient Population

Over a period of 8 years, from January 1983 until December 1990, 177 patients underwent MVD to treat symptoms and signs of unilateral DPV, and an additional 30 patients underwent MVD to treat symptoms and signs of bilateral DPV. In the unilateral group there were 120 women, age 19 to 74 years (mean: 47 years), and 57 men, age 23 to 69 years (mean: 47 years). Of those patients with bilateral symptoms, 23 were women and 7 were men, age 16 to 69 years (mean: 41 years). The duration of the symptoms in patients with unilateral DPV before treatment was 6.5 ± 6 years, and the age at onset for women was 39 years and for men 40 years.

Of the 177 patients who underwent unilateral MVD, 6 did not return for follow-up, of whom 3 died of unrelated causes (malignancy, homicide, and fire). Another 8 patients, 5 female and 3 male, had previously underwent vestibular nerve section through translabyrinthine approach at other institutions and subsequently had "stump decompression" as a second procedure at our institution, but these 8 patients are excluded from this study. The preoperative results that are herewith reported comprise 169 patients with unilateral DPV, and the follow-up results are based on 163 patients, follow-up time being an average of 38 months (a range of 3 months to 10 years).

Of the 30 patients with symptoms and signs of bilateral vascular compression, 1 had a previous vestibular nerve section and is therefore excluded from this study. Seven patients with bilateral DPV had 3 MVD operations, and 1 patient had 2 operations on each side. The third surgical procedure was done 1 to 6 years later because of a recurrence of symptoms and a recurrence of abnormal test results. Three patients had multiple procedures (see page 80).

Preoperative Tests

Auditory tests: All patients who had the symptoms of DPV and were therefore considered to the candidates for MVD operations underwent complete audiological evaluation, including pure tone audiograms and determination of speech discrimination scores using recorded material (NW6 lists) in a sound-insulated booth. Recording of the acoustic middle ear reflex response was done using contralateral recording of the response to stimuli of 0.5, 1, and 2-kHz tones. In addition to determining the threshold of the response, the growth of the reflex response was determined by measuring the amplitude of the response in response to three 5-dB increments of the stimulus intensity. All of the patients had an otoneurological examination, including otomicroscopic examination of the ears and testing of Romberg and sharpened Romberg and gait using a long and wide corridor.

Brainstem auditory evoked potentials (BAEP) were recorded by the method previously described in detail[25]. The stimuli were 2-kHz tonebursts of 1 ms duration or clicks presented at a rate of 10 per second through miniature stereo earphones (Realistic, Radio Shack, Div. of Tandy Corporation, Fort Worth, Texas) at an intensity of 95-dB and 105-dB peak equivalent sound pressure level (pe SPL), respectively. The potentials were recorded differentially from electrodes placed on the forehead or at the vertex and on the ipsilateral mastoid or earlobe, amplified (10 Hz to 3 kHz) (Type P 511 amplifier, Grass Instrument Co., Quincy, Massachusetts), filtered, and averaged with a sampling interval of 40 ms and 256 datapoints in each recording using an LSI 11/23 processor and later an Apollo Domain 3000 workstation. 2,048 responses were averaged and repeated once for each ear. The averaged responses were digitally filtered to enhance the peaks without time displacement using zero-phase digital filters as described by Møller[17]. Computer programs were used to identify the individual peaks and to print their latency without the use of a manual cursor.

Subtle increases in the interpeak latencies (IPL) of peaks I-III of the BAEP elicited from the affected side and/or an increase in IPL III-V from the contralateral ear are considered indications of vascular irritation of the auditory nerve. Our criteria for abnormal BAEP as an indication of vascular compression is an increase in IPL I-III of $=/> 0.2$ ms or an increase in IPL III-V from the contralateral side of $=/> 0.2$ ms (see Fig. 1). An increase in IPL I-III greater than 2.3 ms and IPL III-V greater than 2.2 ms in patients with normal hearing is regarded as abnormal and indicative bilateral DPV.

Vestibular testing: Oculomotor screening tests, recording of spontaneous and positional nystagmus, and caloric testing using 30° and

44 °C water temperature were done in all patients. In some patients also rotational testing was done. Posturography was seldom done because many patients had difficulty standing without support. The vestibular tests were usually performed at the Vestibular Laboratory of the Raymond E. Jordan Center for Balance Disorders at Eye and Ear Insitute of Pittsburgh, and the test results were interpreted by the physician in charge of this laboratory. Some patients had vestibular tests done at their own city's ENT clinic, as these tests require the cessation of all vestibular supressant medications for 48 hours prior to testing and the patients could not travel to Pittsburgh for evaluation without the help of medication.

Imaging studies: All patients had a computer assisted tomography (CT scan) or magnetic resonance imaging (MRI) test as part of their evaluation. Many of them had several imaging procedures done over the years, but these tests were always repeated prior to the operation when it was decided that the patient should undergo surgery.

Operative Procedures and Intraoperative Neurophysiological Monitoring

Microvascular decompression was performed through a retromastoid craniectomy while under general anesthesia with the patient in a contralateral-lateral-decubitus position[10, 11]. In all cases, the flocculus had to be dissected off the nerve. Monitoring of hearing was performed throughout the operation by recording brainstem auditory evoked potentials (BAEP), and in selected cases when the eighth nerve was exposed compound action potentials (CAP) were recorded directly from the nerve[18, 23]. The sound stimulus was either 2-kHz tonebursts (of 1 ms duration) or clicks presented through inert hearing aid earphones and later through miniature stereo earphones[18]. BAEP were recorded on two channels, one differentially between the vertex and the neck (above about the C3 vertebrae) and the other between the two earlobes. The responses were amplified (System 12 amplifier, Grass Instrument Co.) with filter settings of 10 to 3000 Hz. The recorded responses were averaged (40-μs sampling interval) using a LSI 11/73 processor or Apollo Domain workstation and digitally filtered to enhance the characteristic peaks of the responses[17]. The recordings were displayed together with a baseline recording that was obtained before the operation began when the patient was asleep. During the operation, the actual recordings were compared with the baseline record that was displayed superimposed on the actual recording. All recordings were stored on magnetic media for archiving purposes and for later processing.

Postoperative Tests

All patients who were operated on for DPV were examined and had a repeat hearing test and repeat BAEP before discharge from the hospital (6–8 days postoperatively) and 3 or 6 and 12 months later. Not all of the patients were able to return to our institution for these check-ups because of distance, but those who did not return were evaluated regularly by their own physician, in most cases specialists in neurology or internal medicine, and we have maintained contact with most patients by telephone or letters and have reason to believe that these patients would contact us if their situation should worsen.

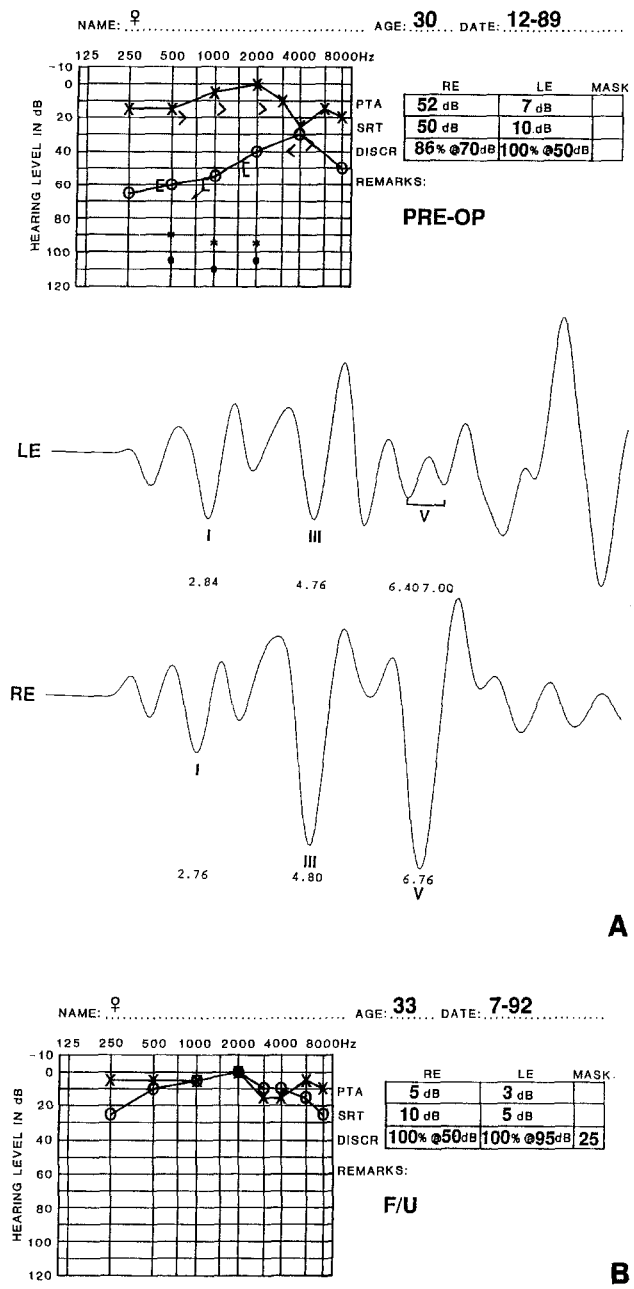

Fig. 1. (A) Results of audiometry and BAEP in a patient with symptoms of DPV for 5 years. Hearing in the right ear slowly worsened without any fluctuations. The acoustic middle ear reflex response is elevated stimulating the right ear, and BAEP shows fluctuating latencies of peak V on the left side, indicating right lateral brainstem compression. (B) Audiometry in the same patient 2 1/2 years later showing marked improvement of hearing. *LE* left ear, *RE* right ear

Results

Results of Preoperative Tests

Of the 169 patients who were selected for MVD on the above mentioned criteria (8 patients who had a previous vestibular nerve section were excluded) and who had unilateral symptoms, as many as 136 had abnormal BAEP, as previously defined. Figures 1 and 2 show typical BAEP changes in patients with DPV prior to operation. Thirty three patients were judged

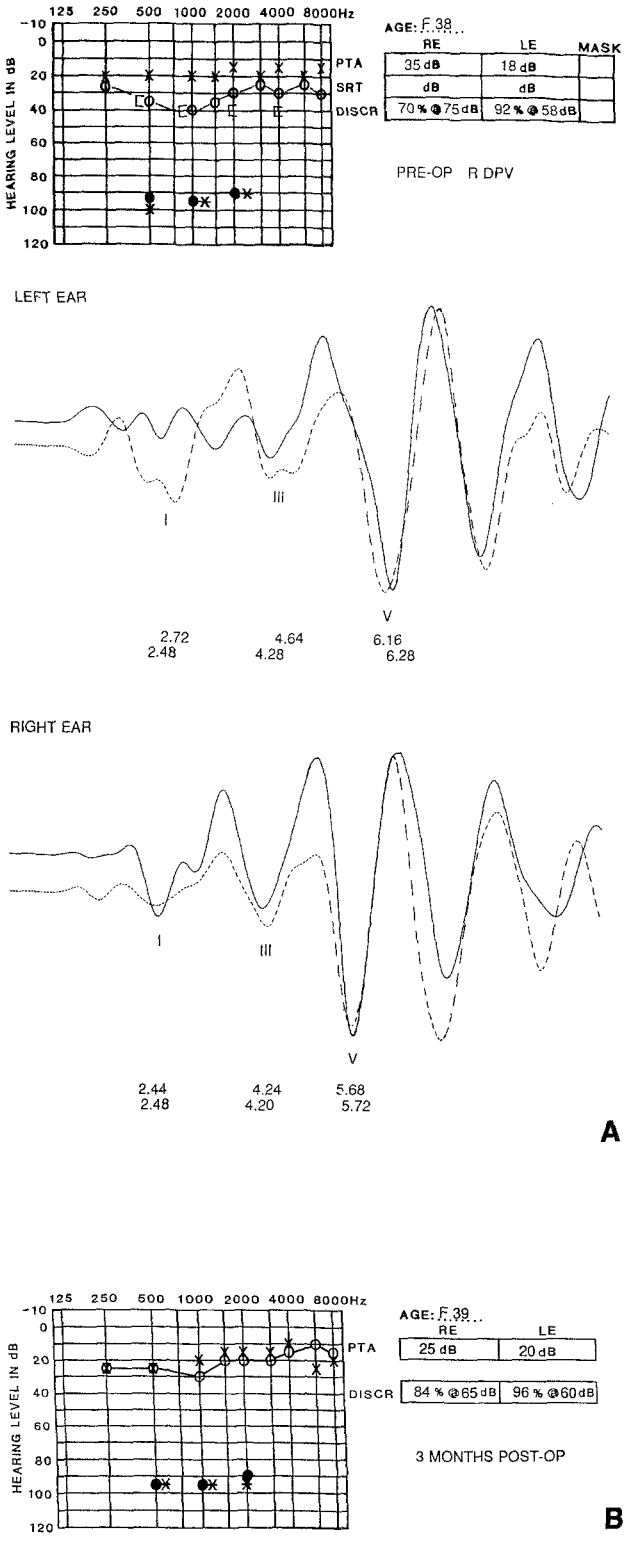

Fig. 2. (A) Results of audiometry and BAEP in a patient with symptoms of DPV for 2 years. The pure tone threshold for the right ear shows a mid-frequency hearing loss (notch) and the speech discrimination score is reduced in the right ear. IPL III-V is prolonged for the left ear.(B) Results of audiometry in the same patient 3 months after MVD showing improved hearing in the right ear

to have normal BAEP recordings. Of these 33 patients, 31 had abnormal results on vestibular tests and, in addition, 19 of them had symptoms from adjacent cranial nerves, such as eye twitching, deep ear pain, face pain, or unilateral hearing loss.

In addition to having abnormal BAEP, as many as 73 patients had abnormal audiometric test results. The most common finding was a flat sensorineural hearing loss in 35 patients, ranging from 35 to 40 dB to advanced losses of 70 to 80 dB (Fig. 2), often with a marked decrease in speech discrimination score. Nine patients had a high-frequency hearing loss more pronounced on the affected side, 21 patients had small notches or dips in the mid-frequency range (1500 to 2000 Hz) on the affected side (see Fig. 3), and 8 patients had a low-frequency up-sloping hearing loss (Fig. 1).

Of the 169 patients selected for MVD, 144 had ab-

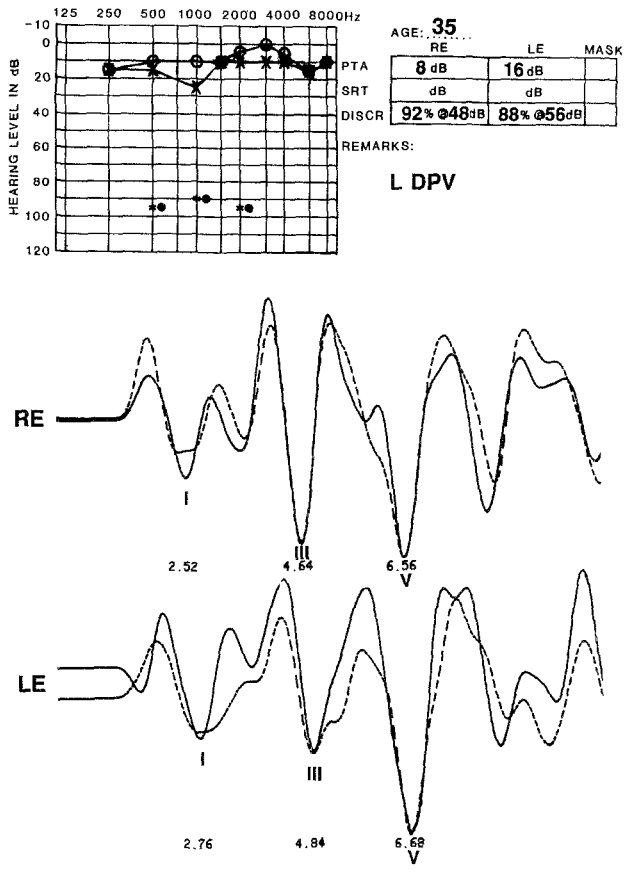

Fig. 3. Results of audiometry and BAEP in a patient with symptoms of DPV on the left side together with atypical V_2 neuralgia, posttraumatic. Notice the "dip" in the pure tone audiogram for the left ear. BAEP shows absent peak II at one testing on the left side and the amplitude was reduced 40% on the left side compared to that on the right side

normal vestibular tests. Most common was a reduced response to caloric stimulation (RVR) in 58 patients, and another 29 patients in addition to RVR had spontaneous nystagmus. Fourteen patients had normal caloric responses but a significant spontaneous nystagmus. The remaining 43 patients had less marked changes, such as positional nystagmus, directional preponderance, or abnormalities on rotational testing or posturography. Fifteen patients had normal vestibular tests and of those, 13 had abnormal BAEP, 1 had a advanced hearing loss, and 1 had severe ear pain in addition to vertigo. Ten patients did not have preoperative vestibular tests, usually because of positive findings on MRI or because they had symptoms of trigeminal neuralgia in addition to DPV. In addition to abnormal tests, 36 patients complained of deep ear pain, 33 had unilateral tinnitus, 6 had bilateral tinnitus, 17 had eye twitching on the affected side, 15 had face pain, and 17 had facial numbness on the affected side.

Of the 29 patients with bilateral symptoms and signs of DPV, 23 had abnormal BAEP, while the results of 6 patients were judged to be normal. Of those with abnormal BAEP, 17 also had abnormal vestibular tests, and of the 6 patients with normal BAEP, 5 had abnormal vestibular tests. In addition, 23 of those patients had symptoms of bilateral ear pain, bilateral eye twitching, or facial pain or numbness.

Operative Findings

Significant vascular compression was found in all patients and frequently the offending vessel(s) (arteries or veins) were found to compress the nerve under the flocculus, often causing a visible grooving in the nerve. There was often multiple compression along the nerve, but in only a few cases was there an arterial loop in the internal auditory meatus.

Postoperative Results

Of the 163 patients (52 men and 111 women) who had MVD for unilateral DPV and who were followed, 129 (40 men and 89 women) were free of symptoms or markedly improved and could return to work, drive a car, and assume normal activities. There was no improvement in 34 patients. Three patients in the failure group suffered varying degrees of hearing loss, and one patient lost hearing totally. These 4 patients later had an auditory nerve section close to the brainstem, but the procedure did not result in improvement in their vertigo. Three patients had no change in their symptoms after MVD, and elected to undergo a second operation. Following the second oepration 1 of these patients is now free of symptoms, while 2 still have the same degree of vertigo; none sustained any hearing deficits. Thus, the MVD operation was successful in 79% (77% men and 80% women). Of the 129 patients in whom the operation was successful, 14 (8 women and 6 men, age 29 to 66 years) had recurrences 1 to 3 years later, 4 of them following motor vehicle accidents. All of these 14 patients elected to undergo a second operation, after which 11 were free of symptoms or markedly improved, while 3 showed no improvement.

Of the 26 patients with bilateral symptoms and who had MVD operations on both sides, 20 (4 men and 16 women) were free of symptoms or markedly improved (77%) and 6 had little or no improvement. Eight of these 26 patients had 3 operations 1 to 6 years apart, and 1 had 4 operations (2 on each side).

In addition of these 26 patients with bilateral DPV, 3 had multiple MVD operations on both sides due to repeatedly recurrent symptoms. One of these patients developed immune reactions (confirmed by histology) to the Teflon implant. Another of these 3 patients, who in addition to DPV had moderate face pain, underwent a third operation – vestibular nerve section – in addition to MVD on the left side. During a third operation on the right side this patient suffered a delayed loss of hearing, and vestibular tests later showed no response on caloric stimulation to ice water. Despite the absence of vestibular response on both sides, this patient still has symptoms of DPV, including severe nausea that results in frequent episodes of dehydration. The third patient who had multiple MVD operations on both sides still complains of DPV symptoms but has no objective findings of DPV and seems to be functional (is able to drive a car). This patient shows signs of depression.

Complications

Of the 169 patients who underwent an operation on one side for DPV, 3 lost hearing as a result of the operation, 1 with no improvement of the vertigo, while 2 are free of symptoms. One of these patients had hearing immediately after the operation but noticed that the hearing faded away at night after the operation. Four patients suffered varying degrees of hearing loss as a result of the MVD operation. While the pure tone audiogram only showed a moderate loss (40 to 60 dB), none of these patients had serviceable hearing for speech. Three of these patients also suffered from tin-

nitus and a feeling of aural pressure in addition to hearing loss and they therefore elected to have a complete eighth nerve section (near the brainstem). Of the 14 patients who had reoperations because of recurrent symptoms, 1 lost hearing. Of the 29 patients who had bilateral operations, 1 lost hearing. This latter patient had hearing immediately after the operation but lost it 24 hours later and had no measurable hearing at the time of discharge. This patient noticed a slow recovery of hearing to nearly pre-operative levels over a 10-month period. As the hearing recovered the symptoms of DPV also returned, and this patient elected to undergo a second operation with sectioning of the eighth nerve and is now free of vertigo.

One patient had a temporary weakness of one vocal cord as a result of injury to the vagal nerve, 1 had a temporary paresis of the superior oblique muscle as a result of injury to the fourth cranial nerve, and 1 had facial weakness. All of these symptoms resolved completely within 3 to 6 months.

Discussion

The results of the present study show that MVD is an effective treatment for patients with a particular symptomatology that we have named "disabling positional vertigo" (DPV)[13]. Thus 79% of such patients who had unilateral DPV symptoms became free of symptoms or markedly improved within 3 to 10 months after the operation. In this respect, DPV is similar to other vascular compression disorders such as trigeminal neuralgia (TN) and hemifacial spasm (HFS), the cure rates of which are between 80 and 85%[19]. Patients with bilateral DPV symptoms have a slightly lower success rate (77%). The mean follow-up time was 38 months, range 3 months to 10 years, and many patients are still in contact with us 8 to 10 years later by letter or telephone. Only 10 patients had a short follow-up time (3 months), 8 of whom considered the operation unsuccessful and were disappointed and 2 of whom considered themselves curved.

We used each patient's own assessment as an indicator of improvement together with an evaluation of their ability to return to normal activities, such as driving a car and whether or not they could return to work and/or sport activities. The finding that vestibular function, as assessed by current vestibular tests, was only significantly affected in 50% of the patients with DPV is another similarity between DPV and other cranial nerve vascular compression disorders such as TN and HFS, which are characterized by essentially normal function. Thus patients with TN have only slightly reduced trigeminal sensibility and patients with HFS have little or no facial weakness between attacks.

The finding that the hearing of several patients with noticeable hearing loss preoperatively improved considerably following MVD indicates that the offending vessel also compressed the auditory nerve and that the effect of compression was reversible (see Figs. 1 and 2).

The fact that there were recurrences (14 patients after having been improved for a period of 1 to 3 years, and 4 of them after motor vehicle accidents) is a further similarity between DPV and TN, which is known to have true recurrences, while HFS differs in that it has practically no recurrences[4].

The cure rate of patients with tinnitus who underwent MVD depended on the duration of the symptoms. It was thus shown in a recent study that those who were cured had had their symptoms for an average of 2.7 ± 2.4 years, whereas those with no improvement had had their tinnitus for an average of 7.4 years $\pm$ 6.6[26]. The results of MVD operations in DPV patients do not depend on the duration of symptoms. It was shown, however, in the same study of patients with tinnitus[26] that there was a noticeable gender difference with regard to the cure rate for tinnitus (55% for women and 29% for men). The present study of patients with DPV showed no such difference between genders (81% of women and 75% of men were relieved from vertigo symptoms). In the failure group, 20% were women and 23% were men (22 and 12 patients, respectively).

More women were treated for DPV than were men (120/57). This is similar to what is seen for TN, in which the incidence of TN is 5.9 for women and 3.4 for men in 100,000. For patients with HFS, there is no such difference between genders, in which the incidence is 0.74 for women and 0.81 for men in 100.000[2].

A total of 254 MVD procedures were reported on in this study. Four patients (1.6%) suffered a total loss of hearing, 1 delayed and one following a second operation. In addition, 4 patients (1.6%) suffered varying degrees of hearing loss.

The fact that those patients (9) who had had vestibular nerve section prior to MVD operations received no relief following MVD indicates that an destructive procedure preceding MVD will result in a unsuccessful outcome of MVD. This is in agreement with results reported by Schwaber and Hall[27].

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