Is surgical vestibular ablation necessary in disabling peripheral vertigo?

A. Mahadevaiah · Bhavin Parikh

Abstract The use of intratympanic gentamicin is an easily performed office procedure for the conservative treatment of the Meniere's disease patient who has failed medical therapy. The procedure provides excellent control for the symptom of vertigo and is one of the most successful methods in the treatment of vertigo due to inner ear disorders. Surgical ablation is no longer necessary for adequate control of vestibular symptoms and that chemical ablation/alteration may replace the need for surgical vestibular ablation in cases of disabling Meniere's disease and other inner ear causes for peripheral vertigo.

Keywords Intratympanic gentamicin · Chemical ablation · Disabling vertigo

Introduction

The healthy vestibular system at rest sends equal resting signals from each vestibular labyrinth to the brainstem. The brain interprets this symmetric input as there being no motion. Partial damage or dysfunction of labyrinth leads to decrease in the firing rate of impulses from the affected labyrinth. As a result of this asymmetric input from the end organs, there is vertigo. Meniere's disease, temporal bone fracture due to road traffic accident and iatrogenic (following tympanoplasty with mastoidectomy) are the common causes of partial damage or dysfunction of labyrinth that usually results in hearing loss, tinnitus and/or vertigo in majority of patients. These symptoms cause significant morbidity and disability. Usually in a few days, the brain suppresses this spontaneous firing and adjusts to the asymmetric input. This central compensation process usually results in relief of the patient's vertigo. For those individuals where persistent disequilibrium or recurring episodic vertigo remains after the passage of time or after treatment medically, chemical or surgical ablation should be considered. The basis for successful chemical or surgical intervention is to render the ear "stable," thus allowing central vestibular compensation to occur. This stability may result from exenteration of the offending labyrinth (labyrinthectomy), denervation of the offending labyrinth (vestibular neurectomy), or ablation of the offending labyrinth (chemical ablation). Complete removal of function from the offending labyrinth is necessary to eliminate the rotational vertigo and persisting unsteadiness and starting central compensation. Surgical elimination of vestibular function (transmastoid or transcanal labyrinthectomy), however, results in total hearing loss in the surgical ear.

During the past 30 years, considerable experience has been gained with vestibular neurectomy (by Middle fossa approach, Retrosigmoid approach or Retrolabyrinthine approach), and consensus has occurred as to the efficacy of these techniques. Vestibular nerve section is an option for hearing preservation with good vertigo control (above

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90%). However, significant hearing loss in such conservative surgery (Middle & posterior fossa surgery) is seen in up to 9%. Also there is considerable risk of facial nerve injury, C.S.F. leak (rare in middle fossa surgery but found in about 5% of posterior fossa surgery) and meningitis [1].

More recently, over the past 10 years, chemical labyrinthectomy has been of increasing interest to otolaryngologists. The procedure is relatively easy to perform, is accomplished in the office environment, is inexpensive, and usually is not disabling. At the present time, intratympanic application of an ototoxic medication, usually gentamicin, is given in varying doses and numbers of installations. It is given to eliminate disequilibrium or to ablate this end organ. Fowler [2] in 1948 produced one of the earliest reports of the use of systemic streptomycin. In 1957, Schuknecht [3] first modified the delivery method and performed middle ear streptomycin perfusion for treatment of unilateral Meniere's disease. All patients had resolution of their vertigo; however, five of eight suffered complete hearing loss. Inconsistent protocols and use of larger doses resulted in hearing loss and the procedure was abandoned for many years. Since then, focus has turned to the use of gentamicin due to its apparent preferential vestibulotoxic effects. Multiple studies [4–20] have shown intratympanic gentamicin to be a relatively safe, effective treatment for unilateral Meniere's disease.

There has been significant variation in methods of administration, dose, schedule, and endpoint of therapy in order to preserve cochlear function. We hereby describe our technique of intratympanic gentamicin that have been adapted from established protocols [10, 13, 17] and modified by our own experience. However we would like to re-emphasize the notation by Monsell and colleagues [21] that says, "From the standpoint of the clinical skills required by the practitioner and the potential morbidity to patients, the administration of aminoglycosides for vertigo by any route of administration should be considered as great an undertaking as surgical treatment".

Materials and methods

A retrospective study was carried out involving 364 patients who underwent intratympanic gentamicin for intractable, disabling vertigo due to labyrinthine dysfunction not resolving with adequate medical treatment during the ten-year period between March 1997 and February 2006. Diagnosis of end organ lesion is very important and was made using proper history taking, clinical examination and relevant investigations. All the patients had vertigo with hearing loss, tinnitus and aural fullness in varying amounts with a few having associated nausea and vomiting. Pure tone audiometry and cold caloric test was performed in all the patients before each injection and one month after the end of therapy. In cases with bilateral Meniere's disease

ITG injection is given in the ear that has more hearing loss and tinnitus. Intratympanic gentamicin was not given in cases of vertigo due to Meniere's disease in only hearing ear. Patients with active ear discharge or tympanic membrane perforation were excluded. The parameters studied were control of rotatory vertigo (complete, partial or none), tinnitus (decrease, same or increase) and change in hearing (improvement, same or worsened depending on decrease or increase in average PTA of 10 dB).

The procedure is carried out as an outpatient visit. We don't feel it necessary to anesthetize the tympanic membrane. Patient lies in supine position, with the affected ear upwards under microscope. One ml of 40 mg/ml gentamicin is taken in a 2 mL syringe. With a 1.5-inch long 26-gauge needle, initially a puncture is made in the anteroinferior quadrant which serves as a pressure relief hole to let air out. Then the needle is inserted through the tympanic membrane into the middle ear at the level of the round window niche and gentamycin is slowly pushed filling the middle ear to assure placement of the drug solution against the round window. Buffered gentamicin reduces the burning sensation that patients may experience. However we use low concentrations of 2% lignocaine in subsequent injections to reduce pain if the patient complains of sting in first injection. The volume injected must be adequate to bathe the round window membrane; usually 0.2 to 1 mL suffices. Some amount of solution may pass through the eustachian tube and some amount comes out in to the canal. The amount of gentamycin instilled is between 10 to 40 mgs, depending on individual middle ear space. The patient remains in the same position for one hour with the head turned in such a way, that the solution is concentrated at the round window. The patient is instructed to keep the ear dry and return after one week. A titration protocol was used giving 4 to 6 injections no more often than once per week and halting when some measure of vestibular function is reduced (absent response to cold caloric test or presence of spontaneous nystagmus), vertigo is controlled, or hearing worsens. A few patients with severe rotatory vertigo or patients who wanted immediate relief from vertigo were also given two injections on consecutive days for faster control of symptoms.

All patients were followed up at the end of 1st month, 3rd month and 6th month of treatment protocol. At the review the patients were assessed by clinical examination and audiometry. In most of the patients after the first injection the intensity of vertigo is reduced. In post-injection period patients may feel unsteadiness for 6–8 weeks until the central compensation takes place. During that period patients are advised to take vestibule sedative drugs and to do adaptation exercises if necessary. Usually 6 injections are enough to achieve total chemical labyrinthectomy in majority of cases. If there is recurrence of vertigo, injection may be repeated once a week until total relief of vertigo is achieved.

Results

The study includes 364 patients with age between 25 and 70 years who underwent intratympanic gentamycin for intractable, disabling vertigo during the ten-year period between March 1997 and February 2006. It includes patients with various causes of peripheral vertigo due to labyrinthine dysfunction not resolving with adequate medical treatment with majority of them (299/364) having unilateral Meniere's disease. Other causes for disabling peripheral vertigo where intratympanic gentamycin therapy was indicated includes post-traumatic (after road traffic accident) or post-tympanoplasty persistent giddiness with severe sensorineural hearing loss (Table 1).

There was complete control of rotatory vertigo in all but 6 cases where partial control was achieved and treatment has to be terminated due to worsening in the hearing status during therapy. A titration protocol consisting of 4 or 6 intratympanic injections were given in 10 and 305 patients respectively no more often than once per week. Caloric test showed no response in all the patients who were given six injections and was absent or depressed in those with two or four injections. Unsteadiness or falling sensation was present in almost all patients who had 6 injections (chemical labyrinthectomy) for a period of six to eight weeks. Unsteadiness was prolonged in patients above 55 years, some of whom were diabetic and/or hypertensive. However, after completion of therapy, all the patients had long-term control of rotatory vertigo and expressed satisfaction after the treatment. 49 patients received intratympanic gentamycin on two consecutive days. Recurrences of subjective vertigo was observed in 47 (10.2%) of the patients between one and half to four years after completion of therapy and were given two more injections. Recurrence was observed in 18/49 (36.8%), 4/10 (40%) and 15/305 (4.9%) in patients with two, four and six injections respectively (Table 2).

Evaluation of hearing results showed no change in hearing status (within 10 dB of pre-operative PTA) in 237 (65.1%) patients, worsening (10 dB or more loss) in 102 (28%) out of whom 90 (24.7%) had loss between 10 to 20 dB and 12 (3.3%) had loss of more than 20 dB. Hearing improved (10 dB or more improvement) in 25 (6.9%). None of the patients had profound sensorineural hearing loss

Table 1 Cause for intractable vertigo

	Number of patients
Meniere's disease	351
Post endolymphatic sac decompression	8
Post tympanoplasty with severe SN loss	3
Post traumatic (Road traffic accident)	2
Total	364

(Table 3). Tinnitus disappeared in 140 (38.5 %), decreased in 87 (23.9%) and remained same in 137 (37.6%) patients after completion of therapy compared to pre-operative status.

Discussion

The non-hydropsic ear seems be relatively resistant to the effects of aminoglycosides and there has been little data to support the use of intratympanic gentamycin to relieve vertigo in patients with peripheral disorders other than Meniere's disease [21]. Therefore one has to be a little extra critical in such cases. The otolaryngologist using intratympanic gentamycin must be confident that the source of vertigo is the labyrinth before proceeding with intratympanic gentamycin treatment. Episodic vertigo has a number of causes, not all of which are peripheral vestibular disorders. Recent study by Brantberg et al [23] has shown equally good response in controlling vertigo attacks in patients with deaf ears after sudden idiopathic sensorineural hearing loss, disabling benign paroxysmal positioning vertigo not responsive to canalith repositioning and vertigo caused by a medium-sized acoustic neuroma in an elderly patient. The role of intratympanic gentamycin therapy may expand for the treatment of vertigo not caused by Meniere's disease. We have successfully used intratympanic gentamycin therapy for vertigo due to temporal bone fracture and iatrogenic (following tympanoplasty with mastoidectomy) cause with total hearing loss.

Treatment of vertigo of inner ear disorder with intratympanic gentamycin has two primary philosophies [22]: chemical ablation versus chemical alteration. While the

Table 2 Recurrences of subjective vertigo

Number of injections	Number of patients (%)	Recurrence Rate (%)
2	49 (13.5)	18/49 (36.8)
4	10 (2.8)	4/10 (40)
6	305 (83.8)	15/305 (4.9)

Table 3 Post-operative Hearing Status

	Number Of Patients (%)
Unchanged (within 10 dB of pre-op level)	237 (65.1)
Worsened (10 dB or more loss)	102 (28)
Loss between 10-20 dB	90 (24.7)
Loss more than 20 dB	12 (3.3)
Profound sensorineural hearing loss	0
Improved (10 dB or more improvement)	25 (6.9)

vertigo control rate is very good in chemical ablation, it has increased risk of loss of cochlear function. Alternatively, chemical alteration is less effective in controlling vertigo but has less chance of adversely affecting hearing. There are also two primary methods of time scheduling perfusions: fixed dosing versus titration. The initial studies [4, 6, 7, 8] involved use of a predetermined fixed schedule of dosing with daily doses or multiple doses daily of gentamicin in which a regular sequential pattern of perfusions is performed until the protocol is complete or adverse side effects are noted. Many centers [10, 13, 15, 17, 19, 20] now use a titration protocol, giving injections no more often than once per week and halting when some measure of vestibular function is reduced, vertigo is controlled, or hearing worsens. Repeated audiometric and vestibular testing is typically employed to guide the titration. In previous studies utilizing both fixed dosing regimens and titration protocols, vertigo control rates were similar, but a significantly higher level of hearing loss was noted in patients receiving fixed-dose perfusions [15, 19]. Though a review of recent literature by Blackley [18] found no significant difference in two regimens, we prefer chemical altering titration schedule compared to chemical ablating fixed dose schedule. The recurrence rates are slightly higher in titration schedule [19, 20], but this recurrent vertigo responded well to additional intratympanic gentamicin injections without changes in hearing. No systematic effects are found for different concentrations of gentamicin (from 10 to 40 mg/mL). Different techniques of delivery (by direct needle injection, tympanostomy tube, microwick or catheter) do not appear to affect the final outcome [18] and therefore direct needle injection, which is easiest, is preferred. Neither the concentration nor the amount delivered affects the efficacy [18] and therapy is terminated based on the effects observed.

Patients with bilateral Meniere's disease present a special management difficulty. Systemic (intramuscular) streptomycin has been recommended as a means of controlling vertigo by inducing bilateral vestibular hypofunction. Systemic streptomycin, however, can produce chronic disequilibrium and oscillopsia, which can be disabling, in up to half of patients [24, 25]. Pyykko et al [26] reported role of bilateral intratympanic gentamicin injections in 14 patients with bilateral Meniere's disease. Rotatory vertigo was controlled in all, with no significant change in hearing. Only 3 patients had enough ongoing disequilibrium to prevent return to work. The role of intratympanic gentamicin in the treatment of bilateral Meniere's disease will undoubtedly be further explored in this challenging group of patients.

Conclusion

A low titration dose intratympanic gentamycin is an easily performed office procedure for the conservative treatment

of vertigo due to peripheral labyrinth dysfunction, mainly Meniere's disease patient who has failed medical therapy and achieves good vertigo control with minimal risk to cochlear function. It appears to be quite popular and may replace vestibular surgery. The risk of additional hearing loss was noted in 28% patients with only 3% having loss of more than 20 dB and none of them having profound sensorineural hearing loss. Vertigo may recur, however, in 10.2% of patients over time. These recurrences can also be treated by intratympanic gentamicin with a similar risk of hearing loss. The salient effect of intratympanic gentamicin is probably the reduction of vestibular function through damage to hair cells, but a complete ablation of function does not seem to be necessary for vertigo control. Senior author (AM) has not performed any surgical procedures in last 8 yrs for relief of vertigo in cases of inner ear disorders.

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