Fenestration and occlusion of posterior semicircular canal for patients with intractable benign paroxysmal positional vertigo

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Abstract

A series of 15 patients with intractable benign paroxysmal positional vertigo (BPPV) who had fenestration and occlusion of the posterior semicircular canal (FOP) surgery commencing in December 1990 are reported. Follow-up was from 14 to 40 months. All patients reported a cure of their positional vertigo. No patient regretted having the surgery. All patients had a negative Dix–Hallpike test post-operatively and the test remained negative for the duration of follow-up. Eight patients had a mild high frequency sensorineural hearing (SNHL) loss post-operatively which had almost recovered six months later. No patient reported any change in their hearing following surgery. Of the 10 patients who did not have pre-operative tinnitus, six developed tinnitus but it was not considered significant by them. All patients developed mild unsteadiness following surgery which gradually improved with mobilization and physiotherapy if necessary.

The operation preserves hearing, is technically straightforward, well-tolerated and effective.

Key words: Vertigo, benign paroxysmal positional; Surgery

Introduction

Benign paroxysmal positional vertigo is thought to represent 17 per cent of all causes of dizziness seen in neuro-otological practice, (Nedzelski *et al.*, 1986). Furthermore, positional nystagmus due to BPPV is reported as being the commonest form of positional nystagmus seen in a vestibular clinic (Gibson, 1988).

On a Dix–Hallpike test, a patient with BPPV will classically develop a rotational nystagmus which beats toward the ground (geotropic). This has a brief latency, rarely more than 15 s and disappears within 20–50 s. The nystagmus reverses direction on sitting the patient up and on repeat testing fatiguability is demonstrated (Dix and Hallpike, 1952).

It has been widely propounded in the literature that the pathology in BPPV lies in the posterior semicircular canal. Perhaps the strongest proof of this is that severing the nerve supply of the canal through a singular neurectomy causes relief of this condition. The theory of cupulolithiasis explains many, but not all, of the aspects related to BPPV. Disturbance in the interplay between the utricle and posterior semicircular canal has also been suggested as a possible aetiology (Fluur and Seigborn, 1974). No further autopsy studies of positional vertigo have been described since those by Schuknecht (1969) and (Michaels, 1988).

While the majority of cases with BPPV settle spontaneously, a few cases remain and disturb the life of the patient for a year or more. It is to these cases with symptoms lasting for more than one year (our definition of intractability) that we offer surgical intervention.

It was Parnes and McClure (1990, 1991) who pioneered the procedure of fenestration and occlusion of the posterior semicircular canal (FOP). Prior to this operation, singular neurectomy was the main operation performed with an attempt to preserve hearing. As an operation singular neurectomy has not been widely embraced by otologists in this country. Furthermore, we note that published literature about singular neurectomy has been largely limited to publications by Gacek (1974, 1982, 1984, 1991). It is our experience that singular neurectomy is a technically demanding operation with significant risk of sensorineural hearing loss. It is for this reason that we regard the FOP operation as a breakthrough in the treatment of BPPV. At least five surgeons in this country are currently performing this operation, a number that indicates an early acceptability for an operation invented in 1990. With this background we present our series of 15 patients who have had the FOP operation for intractable BPPV.

Materials and methods

A series of 15 patients with intractable BPPV were offered the FOP operation starting from December 1990. Five patients were male and 10 female. Their ages ranged between 31 and 64 years with a mean of 49.5 years.

Pre-operative assessment (see Table I)

All patients complained of positional vertigo related to head movement. The duration of the symptoms ranged between one year and 10 years with an average of 5.5

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TABLE I

SUMMARY OF THE PRE-OPERATIVE ASSESSMENT FOR THE 15 PATIENTS

Case no.	Dix–Hallpike Test	Hearing	Tinnitus	Ear examination
Case 1	Classic Left	Normal	Positive Bilateral	Normal
Case 2	Classic Bilateral R>L	High frequency Presbycusis	Positive Bilteral	Normal
Case 3	Classic Right	Mixed Hearing loss Servicable	Nil	Mastoid cavity
Case 4	Atypical No latency No adaptation	Normal	Nil	Normal
Case 5	Classic Right	Profound SNHL	Nil	Normal
Case 6	Classic Left	Normal	Nil	Normal
Case 7	Classic Left	Normal	Nil	Normal
Case 8	Classic Left	Bilateral idiopathic SNHL	Nil	Normal
Case 9	Classic Right	Normal	Nil	Normal
Case 10	Classic Left	Mixed hearing loss	Positive Side of operation	Dry central perforation
Case 11	Atypical No nystagmus	Normal	Nil	Normal
Case 12	Classic Left	Normal	Positive Bilateral	Normal
Case 13	Classic Bilateral R>L	Normal	Positive Bilateral	Normal
Case 14	Atypical No adaptation	Normal	Nil	Normal
Case 15	Atypical No adaptation	Normal	Nil	Normal

years. There was a possible underlying cause for BPPV in seven patients; five had previous head trauma, one had a modified radical mastoidectomy and one patient had, on the affected side, chronic otitis media with a perforated tympanic membrane.

Ten patients out of 15 had completely normal hearing levels on the affected side. One patient had mild noise-induced hearing loss associated with a conductive element averaging about 30 dB and related to the existence of a central perforation; one patient had presbycusis; one patient had a total sensorineural hearing loss (SNHL) from birth on the affected side; a fourth patient had a symmetrical idiopathic SNHL affecting all frequencies and averaging 50 dB; one patient who had had a mastoidectomy on the affected side 25 years previously had 40 dB SNHL with 40 dB conductive loss on average.

The Dix–Hallpike test was performed on all patients pre-operatively. Ten patients had a classic BPPV pattern on one side only. In two patients the test was positive on both sides but with one side more prominent than the other and associated with stronger symptoms. The remaining three patients gave atypical responses: one patient with an intermittent but classic history of BPPV had a nystagmus that showed no latency and no adaptation. The test was repeated on this patient on three separate occasions but the test was positive only once. One patient had positional nystagmus on one side with latency and a classic direction but no adaptability was demonstrated on repeating the test three times. The third patient had vertigo on both sides during positional testing, more prominent on one side, but no positional nystagmus was demonstrated.

Five patients had pre-operative tinnitus: four of these patients had tinnitus on both sides; one patient had uni-

lateral tinnitus on the side of the operation. Ten patients did not experience any tinnitus before the operation.

Ear examination before the operation revealed normal tympanic membranes in all patients except two. Of these one patient (Case 3) had a modified radical mastoidectomy cavity which appeared dry and healthy and the other patient (Case 10) had a dry central perforation on the side of the operation.

Thirteen patients had calorics performed pre-operatively (two patients refused to have the test). Ten patients had normal caloric responses; three patients had hypofunction on the side opposite to that of the operation.

Operation

A cortical mastoidectomy was performed via a post-auricular incision. The lateral semicircular canal and the lateral sinus were identified. The posterior semicircular canal was found running at right angles to the lateral canal. The canal was fenestrated about 3 mm from where it was crossed by the facial nerve although it was not necessary to identify the facial nerve. The bone over the canal was carefully removed using a diamond drill until the blue colour of the canal was revealed. The bone was carefully removed to open the bony canal using a fine pick. The membranous labyrinth was then compressed. In the first patient the canal was packed with a mixture of bone dust and a little clotted blood. In the remaining patients the canal was packed with a mixture of bone wax and bone dust. The fenestration was protected with a small piece of temporalis fascia and the wound closed.

In three cases the hearing was monitored by electrocochleography. There was an almost immediate elevation in

the threshold a few minutes after starting the cortical mastoidectomy. This was assumed to be a threshold shift produced by the noise of the drill. This threshold shift remained and showed no change on opening the posterior canal, but a further elevation in threshold occurred on packing the posterior canal, in all three cases.

Post-operative assessment (see Tables II and III)

Immediately post-operatively all patients felt dizzy. This sensation gradually improved. The duration of the stay in hospital, as an inpatient, varied between three and nine days with an average of four and a half days. One patient had a stormy post-operative course with severe vertigo, nausea and vomiting but gradually settled within nine days. All patients had mild, first degree, horizontal nystagmus on the first post-operative day disappearing after a day or so.

The duration of follow-up ranged from a minimum of 14 months to a maximum of 40 months. All patients reported disappearance of their positional vertigo in relation to the previously offending head positions. None of the patients throughout the duration of follow-up reported a recurrence of their original symptoms.

All patients developed mild unsteadiness following the operation. The sensation was gradually improved by mobilization and physiotherapy. In five patients the sensation completely resolved by the sixth post-operative month. The remainder of the patients, with the exception of one, became totally asymptomatic by one year. None of the patients was prevented from working as a result of this sensation. The only patient who continued to remain unsteady had concomitant depression and improved on antidepressants.

Of the 10 patients who did not have tinnitus pre-operatively, six developed post-operative tinnitus. Only four of these six patients still had tinnitus at six months. None of the patients regarded the tinnitus as being annoying or troublesome.

Only one patient reported a hearing loss at the first post-operative visit. This patient had accidental dislocation of the incus during the operation. A pure tone audiogram documented a 30 dB conductive hearing loss. At approximately six weeks post-operatively, eight patients had mild

high frequency SNHL. By six months, this hearing loss was almost completely reversed.

One patient who had a right-sided operation at the site of a previous modified radical mastoidectomy developed sudden vertigo in association with influenza-like symptoms two years after his operation. Associated with this attack there was a significant drop in hearing levels at all frequencies averaging about 40 dB. The patient had an urgent CT scan of the petrous temporal bones to demonstrate the state of patency of the posterior semicircular canal. There was convincing evidence of occlusion of the posterior semicircular canal.

Eight patients had post-operative caloric testing. One patient had no post-operative function on the operated side (Case 3); five patients had less than 21 per cent difference in function between the two sides; one patient had a 28 per cent difference and the other 31 per cent post-operatively. In our vestibular laboratory we considered a difference of 22 per cent to be significant.

Discussion

It is our belief that patients with BPPV should be given a reasonable chance to undergo spontaneous remission. We therefore consider it unacceptable to offer any form of surgical intervention to patients with symptoms of less than one year's duration. Our strategy concerning surgical intervention is in line with that of Parnes and MacClure (1990, 1991), who pioneered the FOP operation and with Gacek (1991) who pioneered the singular neurectomy approach. Recently, this strategy has been challenged by Anthony (1993) who offered surgery to six of his 14 patients after a duration of symptoms of less than one year and ranging from three months to 11 months. We find it difficult to justify this strategy especially as he described one case who developed a significant permanent hearing loss.

A number of conservative measures have been described in the literature for management of patients with BPPV. These include the liberating manoeuvre of Semont et al. (1988) and Brandt and Daroff's (1980) exercises. While there was some disillusionment in our department

TABLE II
SUMMARY OF THE MAIN RESULTS OF THE POST-OPERATIVE ASSESSMENT

Case no.	Subjective hearing loss	Newly developed tinnitus	Post-operative Dix–Hallpike test	Duration of follow-up
Case 1	Nil	Nil	Negative	24 months
Case 2	Nil	Nil	Negative	26 months
Case 3	Nil	Nil	Negative	40 months
Case 4	Nil	Positive	Negative	34 months
Case 5	Nil	Nil	Negative	36 months
Case 6	Nil	Positive	Negative	40 months
Case 7	Nil	Positive	Negative	34 months
Case 8	Nil	Positive	Negative	27 months
Case 9	Nil	Positive	Negative	27 months
Case 10	Nil	Nil	Negative	26 months
Case 11	Nil	Nil	Negative	32 months
Case 12	Nil	Nil	Negative	31 months
Case 13	Positive	Nil	Negative	40 months
Case 14	Nil	Nil	Negative	14 months
Case 15	Nil	Positive	Negative	32 months

TABLE III
SUMMARY OF THE AVERAGE HEARING LOSS AT THE FREQUENCY RANGE OF 250 Hz–8 kHz FOR THE 15 PATIENTS

Case no.	Average hearing loss at six weeks post-operation	Average hearing loss at six months post-operation
Case 1	+8.3	+1.6
Case 2	-2.5	-4.1
Case 3	+16.6	+13.3
Case 4	+13.3	+7.5
Case 5	+1.6	+1.2
Case 6	-5.8	-5.8
Case 7	+10.0	+1.6
Case 8	+8.3	+2.5
Case 9	-5.0	-6.6
Case 10	+5.8	-4.1
Case 11	+30.8	-7.5
Case 12	+4.1	-1.6
Case 13	+25.8	+19.1*
Case 14	+2.5	+1.5
Case 15	+48.0	+11.6

(+) Indicates hearing loss. (−) Indicates hearing gain. *Conductive hearing loss due to dislocated incus.

concerning the efficacy of these procedures when we first started to offer the FOP procedure, yet it was our strategy that all patients considered for surgical intervention should have tried Semont et al.'s (1988) procedure. In the last two years we have been using the particle reposition manoeuvre as recently described by Lorne and Price-Jones (1993). Only patients who do not respond to this exercise and who follow our duration criteria will be considered for surgery by us.

When Parnes and McClure (1990, 1991) pioneered the FOP operation a few years ago there was a place for it on the surgical map. All that time Labyrinthectomy was considered an effective operation but it destroyed hearing. Vestibular neurectomy was an alternative but, in addition to the inherent risk of craniotomy, it carried a significant risk to the facial and cochlear nerves. Singular neurectomy first described by Gacek (1974) remained a difficult operation to perform. Ohmici et al. (1989) in a study of human temporal bones, showed that the singular nerve was inaccessible in 14 per cent of bones due to the position of the labyrinth. In the hands of Gacek (1991) the risk of permanent sensorineural hearing loss remains four per cent.

The idea of fenestration and occlusion of the posterior semicircular canal, also called ampullary plugging by Pace-Balzan and Rutka (1991) and partitioning by Anthony (1993) is based on the technique initially described, in cats, by Money and Scott (1962). They established that plugging a semicircular canal completely blocked its receptivity without influencing the functions of the other vestibular receptors. While the concept of the pathophysiology of BPPV and hence the mode of action of the FOP seemed straightforward we found that there were a number of interesting observations about BPPV that challenged explanation. These are:

(1) The three patients, with bilateral BPPV, who had FOP performed on one side had resolution of their signs and symptoms on both sides. Parnes and McClure (1990) similarly noted a simultaneous reduction in caloric response on the opposite side and suggested the possibility of a cerebellar 'clamp' effect as being a possible cause.

(2) In two patients from this series a positive Dix–Hallpike test could be elicited up to five days following surgery, despite the surgeon's confidence that the canal was firmly occluded. An identical observation was also noted by Parnes and McClure (1990).

(3) The recent study by Moriarty et al. (1992) showed an incidence of cupular deposits of 28 per cent in the posterior semicircular canal (PSCC), 21 per cent in the lateral semicircular canal (LSCC) and 13 per cent in the superior semicircular canal (SSCC) in normal temporal bones of people who did not have antemortem BPPV. This represents a definite challenge to the theory of cupulolithiasis.

(4) The intermittency of symptoms in chronic cases of BPPV with free intervals in which the Dix–Hallpike test is negative. Six of our patients had intermittent symptoms. This represents a real diagnostic difficulty and shows that the pathology is dynamic in nature. It also emphasizes the need in some patients for repeat testing and multiple neuro-otological consultation to be able to confirm the diagnosis of BPPV.

(5) The report by Morrison (1979) concerning the incidental abolition of BPPV in patients undergoing stapedectomy for otosclerosis.

(6) The existence of atypical variants of BPPV. Four cases have been included in this series. It is interesting to note that all these patients had complete resolution of their symptoms following FOP. The existence of these variations have been only partly addressed in the literature. An example of this is the classification of BPPV into fatiguable and non-fatiguable types by Hall et al. (1979).

We found no one theory, including cupulolithiasis, that could explain all these intriguing observations. The conclusions that can be drawn is that up to this time there is no firm explanation of the pathophysiology of BPPV nor of the exact mode of action of the FOP procedure.

The standard theoretical principle underlying the FOP procedure is the creation of a physiological fixation of the cupula by enclosing a closed fluid-filled space between it and the site of occlusion. It has been suggested by Parnes and McClure (1990) that FOP abolishes the dynamic discharge of the cupula but does not interfere with static cupular discharge at rest. This is believed to be a physiological advantage over singular neurectomy since it indicates that with a FOP there is no static asymmetry between both sides and this translates into better toleration by the patient.

In line with all other reported cases of FOP (Parnes and McClure, 1990, 1991; Pace-Balzan and Rutka, 1991; Dingle et al, 1992, Hawthorne, 1992; Anthony, 1993) we find this operation safe in relation to cochlear function. If the membranous labyrinth is damaged during the operation, as it often is, the hearing does not seem ultimately to be affected. However, there may be immediate partial SNHL, severe nausea and vomiting in the immediate postoperative period. Only eight patients had mild high frequency SNHL that virtually completely recovered within six months. The one patient who sustained irrecoverable SNHL had developed his hearing loss two years after the operation following a viral illness. The possibility of the bone dust being lysed and phagocytosed has been considered and excluded by high definition CT scanning showing evidence of occlusion of the posterior canal. As a result we feel strongly that this particular patient had coincidental viral labyrinthitis.

Conclusion

Fenestration and occlusion of the posterior semicircular canal is a technically straightforward operation which is well tolerated by patients. Safety to hearing has been confirmed in all reported cases.

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