

Incidence and quality of vertigo symptoms after cochlear implantation

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Abstract

Objectives: To assess the incidence of vestibular disturbance in patients after cochlear implantation, and to evaluate the quality of vertigo symptoms.

Study design: Prospective, observational study.

Setting: Cochlear implant centre at a tertiary referral university hospital, Munich, Germany.

Patients: Forty-seven adult patients undergoing unilateral cochlear implantation between 2003 and 2007.

Methods: Patients were interviewed post-operatively about vertigo symptoms, using a specifically designed questionnaire. Questionnaire data were used to define patient subgroups based on probable vertigo aetiology. Cochlear implantation was performed via a retroauricular, transmastoidal approach. Thirty-six implants were Cochlear Nucleus 24 devices and 11 were MedEl devices.

Results: Twenty-one (45 per cent) patients reported vertigo symptoms following cochlear implantation. The time of onset was directly post-operatively in the majority of patients. In 90 per cent, the symptoms suggested an otogenic origin. The majority of patients reported paroxysmal vertigo with a duration of seconds to minutes. Typical concomitant symptoms were tinnitus, fluctuating hearing loss and vegetative reactions. Serious disablement by vertigo was rare.

Conclusion: Exposing patients to the risk of possible balance disorders associated with cochlear implantation is justified in view of the hearing rehabilitation achieved, even with today's broader indications for cochlear implantation. However, patients should in any case be informed about the possibility and quality of post-operative vertigo symptoms.

Key words: Vertigo; Cochlear Implantation; Vestibular Labyrinth; Questionnaires; Hearing Disorders; Deafness

Introduction

Over the last 20 years, cochlear implantation has become a standard tool in the rehabilitation of patients with severe hearing impairment. In the past, patients were required to be almost completely deaf before this procedure could be considered. However, in recent times more liberal indications have led to the implantation of less severely deafened patients achieving insufficient results with hearing aids. Bilateral cochlear implantation, especially in young children, has also become an established concept.

With the broadened indications and increasingly widespread use of cochlear implantation, it has become more important to critically analyse and evaluate the risks and possible side effects of this procedure. One possible complication with a considerable impact on the patient's life is vertigo. A review of the existing literature shows that the reported

frequency of vertigo after cochlear implantation varies widely, ranging from 0.33 to 75 per cent.¹

The causes of such vertigo are controversial. Traumatic labyrinth damage during electrode insertion,² intra-operative perilymph loss,³ foreign body reaction with labyrinthitis,⁴ post-operative perilymph fistula,⁵ endolymphatic hydrops⁶ and electrical vestibular stimulation by the implant⁷ are proposed mechanisms. Furthermore, cases of autoimmune Ménière's syndrome,⁸ Tullio phenomenon⁹ and benign paroxysmal positional vertigo^{10–12} have also been reported.

The balance problems reported by patients can be quite diverse. In some patients, vertigo occurs immediately post-operatively, while in others it takes weeks or months to develop.^{4,6} The findings of vestibular function tests (i.e. spontaneous nystagmus, caloric and rotatory assessment of horizontal semicircular canal function, and posturography) and of standardised vertigo questionnaires (i.e. dizziness

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handicap inventory and assessment of activities-specific balance confidence) have not satisfactorily clarified the cause of such vertigo symptoms.^{1,6,13–17}

The goals of this study were: firstly, to determine patients' frequency of balance disorders following cochlear implantation; and, secondly, to present the results of a specific vertigo symptom questionnaire, thus allowing the definition of patient subgroups based on probable vertigo aetiology.

Materials and methods

Forty-seven consecutive adult patients who underwent unilateral cochlear implantation at our cochlear implant centre between 2003 and 2007 were included in this prospective study. Patients with bilateral implantation or a second implantation in the same ear were excluded. The indications for implantation were bilateral deafness or severe to profound hearing loss without benefit from hearing aids. Fifteen (32 per cent) patients were male and 32 (68 per cent) were female. Patients' ages ranged from 16 to 83 years, with a mean of 54 years. Twenty-six patients were implanted on the right side and 21 on the left side. Multichannel cochlear implants from the Cochlear (Lane Cove, Australia) and MedEl (Innsbruck, Austria) companies were used. Thirty-six (77 per cent) patients were implanted with Nucleus 24 devices (Cochlear) and 11 (23 per cent) patients with Combi40+ or Pulsar devices (MedEl). Patients' causes of deafness are listed in Table I.

In order to investigate vertigo characteristics, the patients were interviewed about vestibular disturbances, using a questionnaire, one week, four weeks, three months and six months after cochlear implantation. The questionnaire was specially developed for this study and aimed to obtain a detailed, standardised description of symptoms in all patients. Patients were first asked whether they had experienced vertigo or imbalance after cochlear implantation. In cases of vertigo, they were asked about the time of onset, quality, frequency, duration, triggering factors, prodromal signs and concomitant symptoms. Finally, patients were asked to rate the intensity of subjective impairment, using a visual analogue scale (VAS), from minimal (= no impairment or harmless) to maximal (= extreme impairment or unbearable). Patients were classified based upon the probable origin of their vestibular symptoms, using the criteria 'quality of vertigo' and

'concomitant symptoms'. Patients with rotatory vertigo, to-and-fro vertigo or 'elevator sensation' and with concomitant ear symptoms such as tinnitus, fluctuating hearing loss or ear pressure were classified into group A (i.e. probable otogenic vertigo). Patients with similar vertigo symptoms but without concomitant ear symptoms were classified into group B (i.e. possible otogenic vertigo). Patients with only unsteadiness and light-headedness were classified into group C (i.e. not otogenic vertigo).

Results and analysis

Analysis of the questionnaires showed that, of the 47 patients, 21 (45 per cent) had developed vestibular disturbances after cochlear implantation. Each characteristic of vertigo was analysed as follows.

Time of onset

More than half of the patients ($n = 11$) experienced vertigo symptoms directly after surgery. In almost one-third, the symptoms started between one day and one week after cochlear implantation. Only four patients had a delayed onset of symptoms – two patients after one to four weeks, one in the first four months and one after six months. The time of vertigo onset is illustrated in Figure 1.

Quality

The quality of the vertigo was described as rotatory by nine (43 per cent) patients and as to-and-fro by 12 (57 per cent). Unsteadiness or light-headedness was described by almost one-third of the patients. Elevator sensation was not described. Multiple answers were possible for this question (percentage values refer to $n = 21$). Figure 2 illustrates these results.

Frequency and duration

The frequency of vertigo attacks was described by most patients (76 per cent) as episodic. Attacks

TABLE I

CAUSES OF DEAFNESS IN COCHLEAR IMPLANTATION PATIENTS

| Cause | Patients | |
|-----------------------|----------|-------|
| | <i>n</i> | % |
| Congenital | 7 | 14.9 |
| Hereditary | 5 | 10.6 |
| Meningitis | 2 | 4.3 |
| Other | 6 | 12.8 |
| Sudden hearing loss | 8 | 17.0 |
| Toxic or drug-induced | 4 | 8.5 |
| Traumatic | 1 | 2.1 |
| Unknown | 14 | 29.8 |
| Total | 47 | 100.0 |

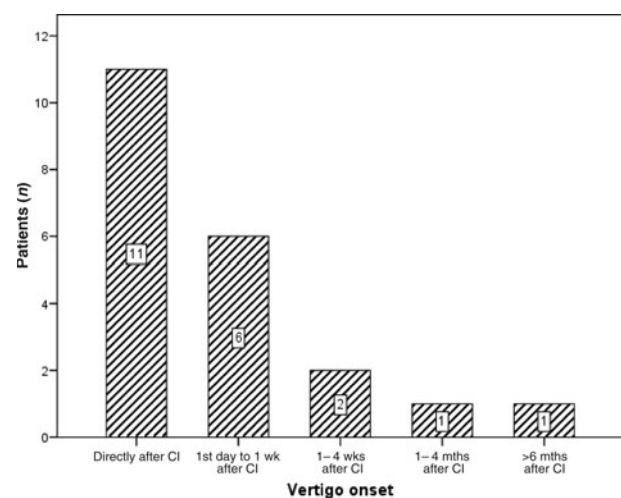


FIG. 1

Time of vertigo onset in 21 patients developing vertigo after cochlear implantation (CI). Numbers in bars indicate total number within each category.

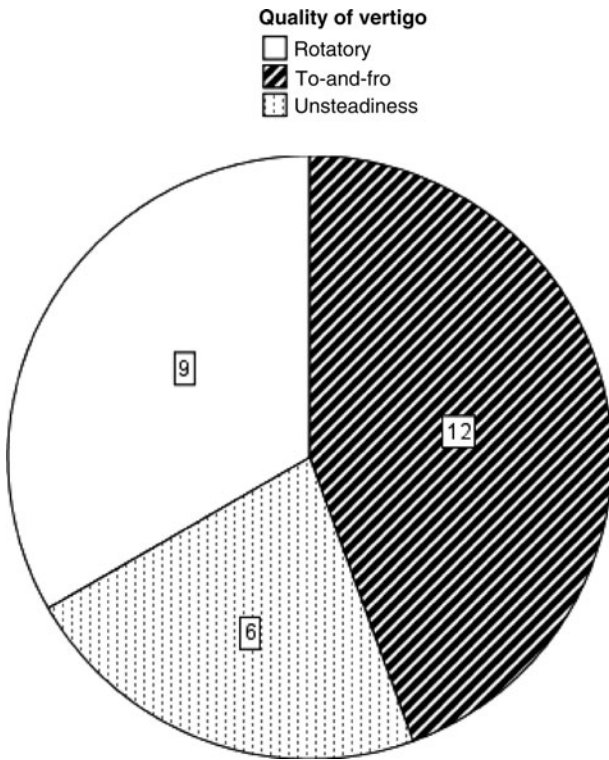


FIG. 2

Quality of vertigo in 21 patients developing vertigo after cochlear implantation (multiple answers were possible). Numbers indicate total number within each category.

were reported as sporadic by 10 (48 per cent) patients, daily by five (23 per cent) and weekly by one. The duration of each attack varied from seconds to days. For most of the patients (48 per cent), the attacks lasted several minutes. In four (19 per cent) patients, they lasted seconds, and in two (10 per cent) patients they lasted several hours. One patient reported a vertigo episode lasting several days. Two patients described their vertigo symptoms as continuous (10 per cent). Two patients reported a very variable frequency and duration.

Triggering factors and prodromal signs

A triggering factor for the vertigo was reported by 12 (57 per cent) patients. These factors were mostly head movements and body movements, such as bending down and climbing downstairs. One patient described loud noises as a triggering factor, and another one described certain times of day as triggering factors. Prodromal signs were reported by five (24 per cent) patients – for instance, aural pressure, tinnitus and neck pain.

Concomitant symptoms

More than two-thirds of the patients (71 per cent) reported concomitant symptoms with their vertigo attacks. A common symptom was tinnitus, occurring in more than one-third (38 per cent) of the study population with vertigo. One patient reported fluctuating hearing loss, and three (14 per cent) patients described

vegetative symptoms. Four patients (19 per cent) had concomitant headache and two (10 per cent) had sweating. One patient experienced fear. For the question about concomitant symptoms, multiple answers were possible (percentage values refer to $n = 21$). Figure 3 illustrates these results.

Subjective impairment

Of the 21 patients with balance disturbance, 19 were able to use the VAS to qualify their subjective impairment. Fourteen (74 per cent) patients marked their impairment within the first half of the scale; five indicated almost no impairment. Five (26 per cent) patients judged their symptoms as more intense; one indicated extreme, unbearable impairment. One patient could not decide upon a specific VAS mark because of very variable impairment, and one patient did not understand the question.

Origin of vertigo

Each patient's questionnaire was also analysed individually, with special attention paid to the reported quality of vertigo and concomitant symptoms. Nine patients were classified into group A (probable otogenic vertigo), 10 into group B (possible otogenic vertigo) and two into group C (not otogenic vertigo). Table II illustrates the distribution of the

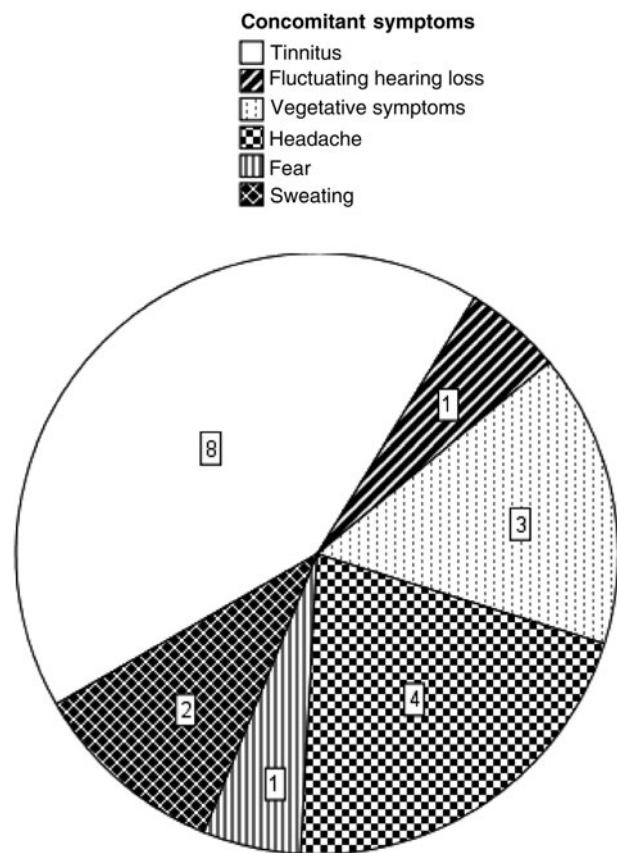


FIG. 3

Concomitant symptoms of 15 patients developing vertigo after cochlear implantation (multiple answers were possible). Numbers indicate total number within each category.

TABLE II
VERTIGO CHARACTERISTICS OF THE 21 AFFECTED COCHLEAR IMPLANTATION PATIENTS

| Pt no | Vertigo quality | | | | Otogenic accompanying symptoms | Vertigo aetiology subgroup |
|-------|-----------------|------------|--------------------|------------------|--------------------------------|----------------------------|
| | Rotatory | To-and-fro | Elevator sensation | Light-headedness | | |
| 2 | - | - | - | + | - | C |
| 4 | - | + | - | - | + | A |
| 6 | - | + | - | - | + | A |
| 7 | - | + | - | - | - | B |
| 9 | - | + | - | + | + | A |
| 10 | + | - | - | - | + | A |
| 12 | + | - | - | - | - | B |
| 18 | + | + | - | - | - | B |
| 19 | - | + | - | - | - | B |
| 23 | - | + | - | + | + | A |
| 24 | + | - | - | - | - | B |
| 27 | - | + | - | + | + | A |
| 31 | - | + | - | - | - | B |
| 36 | - | + | - | - | + | A |
| 38 | + | - | - | - | + | A |
| 39 | + | - | - | - | - | B |
| 40 | + | - | - | - | - | B |
| 41 | - | - | - | + | - | C |
| 42 | + | + | - | - | + | A |
| 43 | - | + | - | - | - | B |
| 44 | + | - | - | + | - | B |

Pt no = patient number; + = yes; - = no; A = probable otogenic vertigo; B = possible otogenic vertigo; C = no otogenic vertigo

patients into these groups. Individual questionnaire analysis suggested a possible or probable otogenic origin in 90 per cent of the symptomatic patients.

Discussion

Our study found that almost half of the cochlear implantation patients suffered vertigo after the procedure. Similar studies have reported variable results (Table III). All studies have described a great variation of frequency and quality of vertigo symptoms after cochlear implantation.

Ito defined three types of vertigo, based upon the time course of symptoms: early type (occurring within two weeks of cochlear implantation), prolonged type (ongoing symptoms) and delayed type (occurring more than two weeks after cochlear implantation).¹⁸ This author found that 58 per cent of patients with vertigo suffered from the early type, 34 per cent from the prolonged type and 8 per cent from the delayed type. Our results corroborate these findings. In most of the affected patients in our study population (76 per cent), vertigo symptoms developed within the first week following cochlear implantation. However, Kubo *et al.* found that as many as one-third of their patients suffered from vertigo only more than one month after implantation.⁴ Of these patients, many experienced vertigo only after more than one year. Similarly, Fina *et al.* reported a high prevalence of vertigo occurring relatively late after cochlear implantation.⁶ These patients suffered from vertigo only months to years post-operatively; causes of vertigo unrelated to cochlear implantation were considered, especially as more than half of the patients were older than 60 years.

Analysis of our patients' individual symptoms showed that most experienced rotatory or to-and-fro vertigo. In three-quarters, this was paroxysmal vertigo with irregular frequency and a duration of seconds to minutes. In almost half of our patients, vertigo was triggered by head and body movements. Typical concomitant symptoms were tinnitus, fluctuating hearing loss and vegetative reactions. Prodromal symptoms were rare. A direct relationship with use of the cochlear implant was not reported.

Therefore, the symptoms in 90 per cent of our patients suggest an otogenic aetiology for their balance disturbance. The occurrence of vertigo immediately post-operatively suggests direct damage to vestibular structures by insertion of the electrode. Histological studies have shown that this can occur. Some other authors

TABLE III
REPORTS ON INCIDENCE OF VERTIGO AFTER COCHLEAR IMPLANTATION

| Study | Pts with vertigo (% (n)) |
|--|----------------------------|
| Buchman <i>et al.</i> ¹ | NS (x/86)* |
| Enticott <i>et al.</i> ¹⁴ | 32 (47/146)*† |
| Filipo <i>et al.</i> ¹⁵ | 67 (14/21, prospective)‡ |
| | 35 (25/72, retrospective)‡ |
| Fina <i>et al.</i> ⁶ | 39 (29/75)‡ |
| Ito ¹⁸ | 47 (26/55)‡ |
| Klenzner <i>et al.</i> ¹⁹ | 12 (12/98)‡ |
| Kubo <i>et al.</i> ⁴ | 49 (46/94)‡ |
| Steenerson <i>et al.</i> ¹⁶ | 75 (35/47)‡ |
| Todt <i>et al.</i> ²⁰ | 53 (33/62)* |
| Present study | 45 (21/47)‡ |

Questionnaire used: *dizziness handicap inventory; †activities-specific balance confidence; ‡specially developed. Pts = patients; NS = not specified

have postulated a late-onset, Ménière-type disorder or labyrinthitis as causes of vertigo following cochlear implantation, but this could not be confirmed in our study population.^{4,6,8}

It is of great interest to identify risk factors that render patients more prone to post-operative vertigo. Age, sex, cause of deafness and pre-operative horizontal semicircular canal function do not seem to have a significant influence.^{1,14} Todt *et al.* demonstrated an effect of the surgical technique used; implantation via a round window approach was associated significantly less frequently with vertigo symptoms than implantation via a cochleostomy technique.²⁰ This was also confirmed by a difference in horizontal canal function (assessed by electronystagmography) and sacculus function (assessed by vestibular evoked myogenic potentials).

- **Vertigo is a common post-operative complication after cochlear implantation**
- **The most common cause seems to be direct damage to the peripheral vestibular organ during electrode insertion**
- **Symptoms mostly occur only transiently and lead to only mild to moderate subjective impairment (seen in two-thirds of the study patients)**
- **Patients should be informed of the possibility and quality of post-operative vertigo symptoms**

Subjective impairment by post-operative vertigo was reported as mild to moderate in two-thirds of our patients. Only one patient was seriously disabled, suffering from continuous vertigo.

Conclusion

Vertigo is a common post-operative complication following cochlear implantation. Approximately one in every two patients is affected. The most common cause seems to be direct damage to the peripheral vestibular organ during electrode insertion. The symptoms mostly occur only transiently and lead to only mild to moderate subjective impairment (present in two-thirds of our patients). Continuous vertigo is a rare complication. Therefore, exposing cochlear implantation patients to the risk of possible balance disorders is justified in view of the hearing rehabilitation achieved, even with the current, broader indications for cochlear implantation. However, patients should in any case be informed about the possibility and quality of post-operative vertigo symptoms.

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