The Journal of Laryngology & Otology (2014), ***128***, *1005–1007.*

doi:10.1017/S0022215114002254

CLINICAL RECORD

Treatment of vertigo and postural instability using visual illusions

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Abstract

Background: Ototoxicity caused by medication can lead to debilitating symptoms such as dizziness, vertigo and postural instability. There is no current 'gold standard' treatment available.

Case report: A 79-year-old male, with bilateral loss of vestibular function caused by gentamicin toxicity after surgery for prosthetic valve endocarditis, complained of dizziness, difficulty in walking and an increased risk of falling. Physical examination showed a positive head thrust test suggesting bilateral loss of vestibular function.

Results: The patient underwent a specific motion-based virtual reality enhanced protocol for peripheral vestibular disease. He showed a great improvement, with a 50 per cent reduction in his Dizziness Handicap Inventory score.

Conclusion: Computer-aided rehabilitation programmes might represent an important advance in gait and posture training.

Key words: Virtual Reality Exposure Therapy; Head Impulse Test; Vestibular Diseases; Postural Balance

Introduction

Dizziness is a common complaint and its incidence increases drastically with age, especially with the use of medication.[1] Dizziness, vertigo and nausea are common symptoms of vestibular disease. For instance, although viral labyrinthitis is self-limiting, it is known to have debilitating effects on balance and posture. Iatrogenic damage to the vestibular system can also cause these symptoms. For example, gentamicin has well-known ototoxicity. When used topically to treat Ménière's disease, it can cause unilateral loss of vestibular function as a side effect. However, bilateral loss is more common,[2,3] and the resulting absence of vestibulo-ocular reflexes causes severe problems in gaze stabilisation while walking or turning the head (oscillopsia). There may be a consequent increased risk of falling.

Restoration of vestibular function is not yet a clinical option. Therefore, treatment is usually symptomatic and consists of vestibular rehabilitation exercises.[4] Recently, Mert showed that virtual reality visual field rotation can help maintain balance while walking.[5] Whitney *et al.* exposed patients with unilateral vestibular loss to a virtual reality grocery store scenario. These authors concluded that such virtual scenarios could be used in patient training, but that further research is needed.[6] Rabago and Wilken reported a case study in which visual field translations were successful in reducing the symptoms of dizziness associated with mild brain injury.[7]

We offered horizontal field translations to an elderly patient with the aim of ameliorating his symptoms of bilateral loss of the vestibular system in the chronic phase.

Case report

A 79-year-old retired air force pilot presented with a five-month history of loss of equilibrium and oscillopsia. The symptoms commenced after high-dose intravenous gentamicin (240 mg for 42 days) treatment for infection of his aortic valve bioprosthesis. After antibiotic treatment, he underwent thoracic surgery to implant a human valve. Post-operative recovery was swift, except for walking difficulties.

The patient was seen at the out-patient ENT clinic. After assessment, because of a positive head thrust test[8] and the close temporal relationship between gentamicin administration and the start of his symptoms, it was concluded that he was suffering from iatrogenic loss of vestibular function resulting from gentamicin otoxicity. The patient had received vestibular rehabilitation exercises as treatment for his complaints prior to his visit, but the results were unsatisfactory.

He was exposed in a computer-assisted rehabilitation environment to optokinetic stimulation through random horizontal field translations of increasing intensity (Figure 1). He received 10 sessions of 15 minutes, 3 times a week.[9] In these sessions, he had to walk at a fixed pace of 3.5 km/hour along a path lined with pillars. The entire virtual visual field was randomly translated to either the left or right. The maximum visual sway was set at each session, and was increased in the following session if the operator deemed the walking pattern to be 'unperturbed'.

Initially, the visual perturbations resulted in gross gait asymmetry, a falling response and a feeling of 'pressure in the head', but with no nausea. After the seventh session, gait asymmetry and a falling response were no longer

Accepted for publication 3 February 2014 First published online 15 October 2014

FIG. 1
The Computer-Assisted Rehabilitation Environment ('CAREN')

observed during visual perturbations. The feeling of pressure in the head had also disappeared.

The patient's Dizziness Handicap Inventory score prior to starting this treatment was 16 out of 100. This was reassessed at two weeks and at six months after the therapy. On both occasions his score was 8 out of 100, representing a 50 per cent reduction. At the most recent visit, he told us that he had a full social life and had started playing golf again. The latter meant he was able to walk for 3 hours. Moreover, his subjective tendency to fall had disappeared.

Discussion

Permanent bilateral vestibular dysfunction may be caused by gentamicin. There seems to be no safe gentamicin dose, and if symptoms occur during treatment, discontinuation of the drug may be the only way to reduce permanent ototoxicity.[3] Treatment of peripheral vestibular disease symptoms in the chronic phase is difficult.[4] A recent review by Cabrera Kang and Tusa showed no convincing evidence that current adaptation or substitution exercises for bilateral vestibular loss are effective.[10] Moreover, there is a lack of effective medical treatment. If vestibular rehabilitation exercises do not help, the doctor can usually only reassure the patient that the symptoms will fade in time and that it is a 'benign' condition. This is not a very reassuring prospect for the patient. However, there have been some recent developments. Surgical implantation of vestibular prostheses has shown promising results, but this technique is still in its infancy.[11] In addition, Mert successfully implemented the use of whole-body sinusoidal vertical movements of increasing size (maximum 40 cm) at a frequency of 0.2 Hz on a motion platform to decrease symptoms in the chronic phase.[5] The efficacy of this process, which he calls 'equilibrium reprocessing', suggests the existence of central compensatory mechanisms. Moreover, Winkler *et al.* have successfully used tilt perturbations to decrease symptoms.[12]

This case study shows that, in addition to vestibular rehabilitation and controlled vestibular desensitisation, purely visual horizontal perturbations might also be helpful. More importantly, however, rapid adaptation can take place even in the chronic phase, leading to improved daily functioning. Furthermore, the time needed for symptom amelioration to occur was considerably shorter compared with treatment involving physical exercises. Two studies performed by Brown *et al*. showed that improvements took place after an average of 3.8 months, with a mean treatment period of 5 months;[13,14] in contrast, our patient experienced a clinically relevant improvement in a couple of weeks.

This experimental treatment raises a question as to the possible therapeutic mechanism. Entire external horizontal field translations to the right or left while walking forward usually occur when falling. The visual vertical shifts accordingly and thus a compensatory mechanism, in this case a side step, is initiated to maintain posture. The subjective vertical mismatch theory postulates that when the perceived vertical and expected vertical (based on previous experience) are at variance, disorientation and/or motion sickness can occur.[15] Adding novel disorientation and/or motion sickness inducing input to the system causes a change to the 'previous experience'. Sensory information of visual, vestibular and proprioceptive signals can be reweighted and subjective vertical mismatch decreased, causing fewer symptoms.[5]

- **An elderly patient presented with loss of equilibrium and oscillopsia**
- **His symptoms started after intravenous gentamicin treatment**
- **He was treated using a computer-assisted rehabilitation environment**
- **Within weeks, his Dizziness Handicap Inventory score decreased and symptoms disappeared**
- **This response is faster than with any current therapies**
- **Computer-aided rehabilitation programmes might represent an important advance in gait and posture training**

The Dizziness Handicap Inventory measures the self-perceived impact of dizziness on everyday life. It assesses the functional, emotional and physical domains of dizziness. A 10 per cent reduction is considered clinically significant.[16] One criticism of this case report might be that our patient had a relative low Dizziness Handicap Inventory score. Even so, we were able to quickly reduce his symptom severity and maintain the reduction for a prolonged period, thus enabling the patient to increase his activity level. Another criticism could be that electronystagmography was not included in our clinical work-up to rule out the possibility of vestibular hyporeflexia. We omitted this step because of the patient's age.

However, the results of this case study are in line with those of other studies[5,6,12] which showed that regular vestibular rehabilitation exercises[4] did not lead to a satisfactory reduction in symptoms. The use of virtual reality combined with motion platforms has successfully achieved prolonged amelioration of symptoms, even in the chronic phase of the condition. Although more research is needed, virtual reality aided postural training is safe and should be considered in cases in which regular vestibular rehabilitation has had an unsatisfactory outcome.

Conclusion

Vestibular ototoxicity is known to occur following gentamicin use. There is no 'gold standard' treatment for the

https://doi.org/10.1017/S0022215114002254 Published online by Cambridge University Press

symptoms of peripheral vestibular disease in the chronic phase. Computer-assisted rehabilitation environments that challenge the subjective vertical might offer new ways to quickly ameliorate symptoms and increase the patient's levels of functioning.

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Dr G van Kerckhoven takes responsibility for the integrity of the content of the paper
Competing interests: None declared

https://doi.org/10.1017/S0022215114002254 Published online by Cambridge University Press