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Objective measurement of the benefit of walking sticks in peripheral vestibular balance disorders, using the Sway Weigh balance platform

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Abstract
Following a lesion in the vestibular system visual, proprioceptive and residual vestibular information is integrated by the brain, to enable a patient to attain equilibrium. The basis of vestibular rehabilitation is to encourage these adaptive and compensatory mechanisms. Another form of rehabilitation is to provide some form of mechanical aid, and walking sticks are often used for this purpose in patients with balance disorders.

There are no reported studies objectively assessing the use of walking sticks in patients with balance disorders. In this study we used the Sway Weigh balance platform (Raymar) to determine the efficacy of a walking stick in 25 patients with peripheral vestibular balance disorders. Patients were tested with their eyes opened and eyes closed whilst they were standing on a flat surface and on an air-filled bed (to alter limb proprioception) on the Sway Weigh balance platform. All the tests were carried out with, and without, a walking stick. The results demonstrate that a walking stick significantly reduces lateral body sway in patients with peripheral vestibular balance disorders.

Key words: Canes; Vestibular diseases, peripheral; Vestibular function tests

Introduction

The management of patients with a vestibular disorder is a particularly evocative subject. The symptoms of dizziness and imbalance may spontaneously resolve within three to six months, but when symptoms persist, the patient may become chronically disabled causing considerable long-term disruption to daily life. Yardley *et al.* (1994) reported that significant levels of handicap remained static during a longitudinal study of chronic vertigo.

Many patients with persistent symptoms report relief whilst taking vestibular suppressant medication. However, the long-term effects of medication on balance are unknown and side effects may limit the usefulness of medication in some patients. Konrad and his co-workers stated in 1992 that vestibular suppressive medication should be restricted to the management of severe acute symptoms only, because long-term use of such medication may impair rehabilitation (Konrad *et al.*, 1992).

Vestibular rehabilitation involving a multidisciplinary team of professionals is a proven method of improving long-term vestibular compensation (Cohen *et al.*, 1992). Horak *et al.* (1992) reported that although a general exercise approach or medication did in fact improve some objective measures of dizziness, vestibular rehabilitation was the most effective treatment for improving balance.

There is a body of literature discussing the use of the Cawthorne and Cooksey exercises for the re-education of the balance system (Cawthorne, 1945; Cooksey, 1945). They developed a set of general eye-head movements exercises, nonspecific for an individual patient's symptoms. Similarly, Brandt *et al.* (1980) reported that positional dizziness could be relieved in many patients by giving them general habituation exercises. One of the main contributors to the current understanding of, and the practise of vestibular rehabilitation is Dix (1974, 1979, 1984), and she described the method of rehabilitation as being that of provoking deliberately and systematically as many spells of vertigo as can be tolerated. More recently, Norre *et al.* (1987) demonstrated that habituation exercises more specific to the particular positions and movements that provoke a patient's dizziness were more effective than a general exercise programme in relieving symptoms of dizziness. Konrad *et al.* (1992), stated that in order for rehabilitation exercises to be effective they must

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include head movements with vision and the exercises should begin as soon after the vestibular injury as possible. Dix (1984) recommended that the exercises be performed in groups so that the individual can see others who have progressed further through the exercises than themselves.

A study by Drachman and Hart (1972), surveying the causes of dizziness in a series of patients suggested that hyperventilation can account for 30 per cent of the patients presenting with dizziness to a clinic. There is also the danger that, if the patient proceeds too early to strenuous balance exercises, the hyperventilation response may induce dizziness. In these cases, the slow breathing exercises described by Pilgrim (1986), coupled with the use of self-relaxation techniques described by Lum (1977) have been proved beneficial.

Posturography can provide the clinician with functional data regarding the relative contributions of each sensory input to the achievement of a stable standing position. Shepard *et al.* (1993) showed 80 per cent improvement in patients having customized vestibular rehabilitation as measured by posturography and that this correlated with improvement in symptoms and disability scores. Norre (1993a) demonstrated several patterns of sensory organization of the compensatory process. A similar study (Roland *et al.*, 1995) carried out on a Sway Weigh machine using the Norre (1993b) scheme (t1, t2, t4, t5) demonstrated that the Sway Weigh balance platform was a simple and comparatively cheap device which effectively measured lateral body sway. Furthermore, the study demonstrated an increase in body sway if the limb proprioceptive inputs were altered in patients with vestibular disorders.

In the Sway Weigh balance platform the standard deviation of the percentage body weight on the right foot (SD F) represents the distance travelled by the centre of pressure of the patient, in their lateral body sway (left–right). Whereas the standard deviation of the rate of change of force per unit time (SD DF) represents the velocity of the movement of the centre of pressure in the left to right movement. The distance travelled by the centre of pressure (sway path) is represented by a derived measure from SD F and its velocity by a derived measure from SD DF.

The role of mechanical aids although generally felt to be useful, has not yet been investigated in a group of patients with dizziness of varying aetiology. It is the aim of this study to evaluate the use of a walking stick using Sway Weigh posturographic assessment in patients with vestibular disorders. Walking sticks with swan neck-shaped handles are preferred for patients with a balance problem, as the centre of balance is brought directly over the stick (Mulley, 1988).

Patients and methods

Twenty-five patients who attended the Neuro-tology Clinic at Walton Hospital, Liverpool, with dizziness due to peripheral vestibular disorders were recruited for this study. The age range of the patients was 57–73 years (mean age 66 years). A history, examination and audiovestibular tests were obtained in an attempt to exclude patients with balance disorders other than those due to disease of the peripheral vestibular system.

The Sway Weigh machine (Raymar) was used for the objective assessment of lateral body sway in the study patients. It is an electronic aid for the assessment and training of balance skills. The essence of Sway Weigh measurement is that the weight carried through one of the patient's feet is detected by the load sensitive plate and is referenced to the patient's full body weight when standing with both feet on the load sensitive plate. A visual display on a BBC microcomputer provides the reading of percentage bodyweight on the right foot, the distance the centre of pressure of the patient travelled and its velocity.

An adjustable lightweight aluminium walking stick, obtained from the Physiotherapy Department was used as the standard mechanical aid. It was fitted with a swan neck-shaped handle, and a soft rubber tip with flared sides and a flat base to prevent slipping.

The lateral body sway of these patients were tested using the Sway Weigh balance platform in a brightly lit spacious room. The platform was placed three feet from the facing wall. The tests were carried out with the eyes opened (T1), and eyes closed (T2) whilst the balance platform was on a flat hard surface. Recording of body sway was measured again with eyes opened (T3), and eyes closed (T4) with the balance platform on an air-filled bed, in order to alter limb proprioception. These tests were equivalent to the tests t1, t2, t4 and t5 in Norre scheme of static posturography (Norre, 1993b).

The recordings of postural movements commenced 10 s after the patient stood up in order to eliminate transient phenomena. The patients were allowed to wear shoes if they felt most comfortable with them and 15 s of recordings were taken at each test. Once the tests were completed each patient was allowed to steady himself and the tests were repeated with patients holding onto the walking sticks. The length of the walking stick was adjusted to each individual's needs, by a physiotherapist, by measuring the distance from the proximal wrist crease to the ground whilst the patient was standing. The walking stick was held in either hand according to patient's own preference. At all times during the test, the tip of the walking stick was placed on floor and when the balance platform was repositioned on the air-filled bed the necessary adjustment to the length made.

The results were collected onto a BBC micro-computer. For each trial the programme measured the force (F), i.e. the percentage body weight on the right foot, and the rate of change of force (DF) per unit time (50 ms). Lateral weight distribution and sway were analysed by comparing mean F, standard deviation of F (SD F), and the standard deviation of DF (SD DF) over the whole trial of 15 s.

TABLE I
THE MEAN VALUES OF F, SD F AND SD DF WITH EYES OPENED AND EYES CLOSED ON THE AIR-FILLED BED, WITHOUT THE WALKING STICK

	T 1	T 2	T 3	T 4
F	57.9	56.19	58.15	57.74
SD F	2.91	3.72	5.94	13.41
SD DF	0.38	0.51	0.86	1.52

TABLE II
THE MEAN VALUES OF F, SD F AND SD DF WITH EYES OPENED AND EYES CLOSED ON THE AIR-FILLED BED, WITH THE WALKING STICK

	T 1	T 2	T 3	T 4
F	56.8	54.6	56.53	56.57
SD F	2.38	3.26	2.78	7.12
SD DF	0.31	0.47	0.4	0.85

Results

Table I shows the mean values of F, SD F and SD DF in the study patients without walking stick on the Sway Weigh balance platform with eyes opened and eyes closed respectively on the hard surface and on the air-filled bed. Table II shows similar data using the walking stick.

The average force (F) on the right foot showed a small difference in the mean and median values between the two groups which was statistically significant. This data were tested for normality using the Shapiro-Wilk test and all the (F) data conformed to a normal distribution. The changes in paired data were assessed using the Student's-*t* test. For F, the values are shown in Table III.

The standard deviation of percentage body weight on the right foot (SD F) and the standard deviation of rate of change of force (SD DF) show significant difference with eyes opened and closed when the balance platform was on the flat surface and on an air-filled bed. The difference was more marked on the air-filled bed than on the flat surface. The use of a walking stick considerably improved both measurements of lateral body sway. The distributions of the SD F and SD DF data did not conform to a normal distribution using the Shapiro-Wilk test. These values were therefore analysed using the non-parametric Wilcoxon Sign Rank test. For SD F, the values are shown in Table IV.

Figures 1, 2 and 3 compare the median values of F, SD F and SD DF in T1, T2, T3 and T4 between the two groups.

The results demonstrate that the use of a walking stick in patients with peripheral vestibular balance disorders reduces lateral body sway compared with when a walking stick was not used. The results were significant in four categories of the Norre scheme (Norre, 1993b).

Discussion

The value F represents the proportion of body weight on the right foot reported as a percentage. The load sensitive plate on the Sway Weigh platform is placed under the right foot. Thus when a patient stands the mean value of F is greater than 50 if more weight is distributed on to the right foot, and less when the left foot bears more weight. Interestingly all the right-handed patients in the study had F values greater than 50 and the left-handed patients below 50 when they were static. The median F value was greater than 50 because there were a majority of right-handed individuals in the study. The median and mean values of F only showed a small difference before, and after, the use of a walking stick regardless of visual and limb proprioceptive inputs. However this difference was statistically significant (Table III). The use of a walking stick may have caused the patient to lean on the stick and made a significant decrease in the weight upon the platform. This is not however proved by this study and it would need a pressure sensor on the foot of the walking stick to investigate this further.

In the presence of unaltered limb proprioception (tests T1, T2) the two parameters SD F, SD DF showed a statistically significant difference. This difference was not great however despite the fact that in test T2 the visual input was impaired. When limb proprioceptive inputs were altered in the presence of normal visual input (test T3) use of the walking stick reduced the values of SD F and SD DF by a significant amount. This represents a significantly reduced lateral body sway in the present groups of dizzy patients. In test T4 both visual and limb proprioceptive inputs were altered and patients demonstrated greatly increased lateral body sway both in distance (median SD F = 12.3) and in velocity (median SD DF = 1.4). The use of the walking stick significantly improved these values. From these results, it is evident that in dizzy patients both mean and median values of SD F and SD DF show about 50 per cent improvement in the body sway in the presence of a walking stick in tests T3 and T4 (i.e. when the limb proprioceptions were altered). However the magnitude of the improvement was almost the same in both these tests. The improvement in the body sway in these dizzy patients when the limb proprioceptions were altered was due to increased perception by the walking stick.

Vestibular rehabilitation as a method of therapy for dizziness is as important as medical and surgical

TABLE III
STUDENT'S T-TEST FOR F WITHOUT THE WALKING STICK *VERSUS* WITH THE WALKING STICK.

	F	
	t 24	*p*-value
T 1	3.1	0.0049
T 2	3.65	0.0013
T 3	5.89	0.0001
T 4	4.35	0.0002

TABLE IV
WILCOXAN SIGN RANK TEST FOR SD F WITHOUT THE WALKING STICK *VERSUS* WITH THE WALKING STICK

	SD F *p*-value
T 1	0.0058
T 2	0.1389
T 3	0.0005
T 4	0.0001

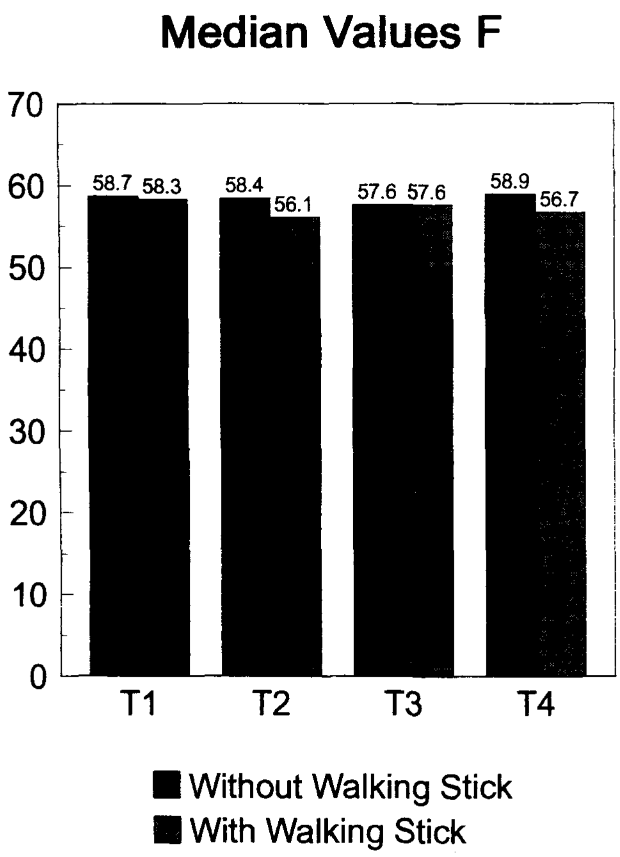

FIG. 1

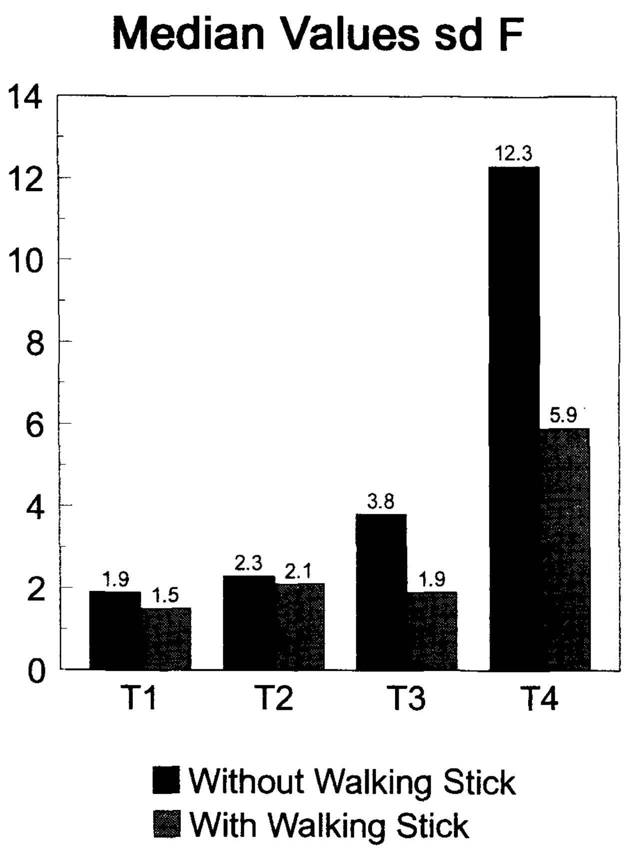

FIG. 2

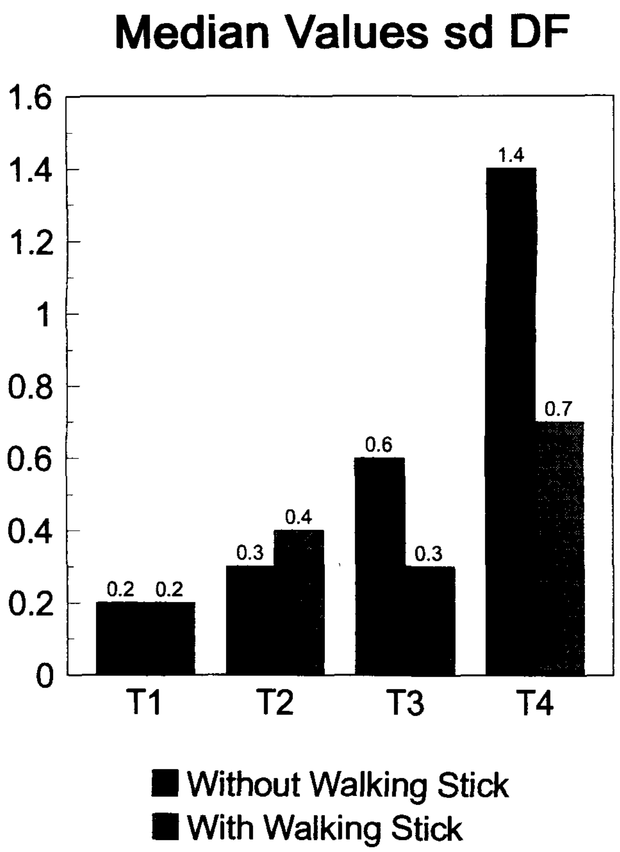

FIG. 3

therapy. The use of a co-ordinated team of professionals is an effective and efficient way to manage patients with vestibular and balance disorders. Various forms of rehabilitative therapy have been described in order to promote central adaptation.

Most of the literature on vestibular rehabilitation revolves around the different modalities of exercise programmes. Evidence for mechanical aids as an adjuvant treatment in the rehabilitative therapy is lacking in the literature. In clinical practice walking sticks are commonly offered. Walking sticks reduce the fear of instability and aid locomotion in hemiplegia. They relieve pain by giving support in musculo-skeletal disorders and therefore improve mobility. In degenerative joint conditions affecting the legs the stick aids walking by transmitting some of the body's weight through the arm.

The results of our study demonstrates that there was a significant increase in lateral body sway when limb proprioception was altered in patients with peripheral vestibular balance disorders. With the limb proprioception altered, the additional proprioceptive input provided by a walking stick significantly reduces lateral body sway.

Conclusion

This study provides objective evidence that a walking stick reduces body sway in patients with peripheral vestibular balance disorders. It can be an invaluable aid in rehabilitation of such patients. Whether its use should be of long-term or short-term depends on the patient's recovery of balance.

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