

Effects of home training and additional physical therapy on recovery after acute unilateral vestibular loss – a randomized study

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Objective: To evaluate the effects of additional physical therapy on recovery after acute unilateral vestibular loss given to patients receiving home training.

Design: Randomized controlled trial.

Setting: Ear, nose and throat departments in three hospitals.

Subjects: Fifty-four patients (mean age 52 years) with acute unilateral vestibular loss within the last week confirmed with electronystagmography testing were included. Patients with central neurologic or auditory symptoms or other vertigo disease were excluded.

Interventions: Home training with or without additional physical therapy 12 times during 10 weeks.

Main measures: Electronystagmography testing was performed before and after the training period. Clinical static (Romberg's test, sharpened Romberg's test, standing on foam and standing on one leg) and dynamic (walking forward and backward on a line) balance tests and subjective ratings of vertigo and balance problems on a visual analogue scale were done one week, 10 weeks and six months after the start of training.

Results: Similar changes were seen in the two training groups.

Conclusions: No significant differences in outcome regarding balance function or perceived symptoms were found between home training with or without additional physical therapy.

Introduction

Partial or total acute unilateral vestibular loss is the third most common cause of peripheral vestibular vertigo after benign paroxysmal positional vertigo and Ménière's disease.¹ The cause of the vestibular loss is often unknown, but possible

causes are viral or other infectious agents, or vascular disorders. The acute loss of vestibular signals from one of the vestibular organs causes a sudden onset of spontaneous nystagmus beating towards the healthy side, vertigo, nausea, vomiting and dysequilibrium. In most patients the acute stage of severe vertigo lasts for one to three days. After that the patient has no symptoms at rest, but for a prolonged time there is still a headshake nystagmus, gradually reduced dysequilibrium, and vertigo can be provoked by head movements.² The time course of recovery differs between individuals

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and between different functions in the same individual. Primarily motion-provoked symptoms can be present for a long period; about half of the patients report some kind of remaining symptoms after one year.³ The symptoms become reduced due to vestibular compensation including processes of gradual recovery of gaze and postural stability.^{4,5}

Vestibular rehabilitation for patients with acute unilateral vestibular loss aims to stimulate the vestibular compensation processes.^{6,7} The intervention includes eye and head movements to improve visual-vestibular interaction and tolerance for movements. Exercises in standing and walking are included to improve static and dynamic postural control.

Most previous controlled studies concerning the effects of vestibular rehabilitation after unilateral vestibular loss have included other patient groups; mixed diagnoses,⁸⁻¹⁰ patients with chronic peripheral vestibular dysfunction,^{11,12} ablative vestibular surgery,¹³⁻¹⁵ or patients with no recovery of vestibular function only.¹⁶ Acceptance of the value of exercise after acute unilateral vestibular loss is increasing, but there is a need for research concerning the effects of different degrees of training intensity, and about how intense the training needs to be for different individuals.

The objective of the present study was to evaluate the effects of additional physical therapy on recovery after acute unilateral vestibular loss given to patients receiving home training.

Methods

In this randomized controlled trial patients were included from ear, nose and throat departments in three hospitals, and followed for six months. The study reports of the effects of home training or additional physical therapy. Influence of asymmetry of vestibular caloric response and age are described in another study.¹⁷

Subjects

All patients with acute unilateral vestibular loss who fulfilled the criteria and agreed to participate were included in the study. The inclusion criteria were: (1) sudden onset of vertigo and nausea

within the last week, and (2) absent or >20% (our own laboratory specific normal limits) reduced caloric response (asymmetry of vestibular caloric response) in one ear confirmed with electronystagmography (ENG) testing. Patients with (1) central neurologic symptoms, (2) associated auditory symptoms or (3) symptoms of other vertigo disease were excluded.

A total of 54 patients (29 men and 25 women) with a mean age of 52 years (standard deviation (SD) 13, range 27-78) were included. Values for one patient are missing for both the 10-week and six-month follow-ups because for unknown reasons the patient did not want to continue. Values are missing for two patients at the six-month follow-up only, because of new acute vestibular loss on the other side after three and five months, respectively (Figure 1).

Intervention

As soon as possible after the ENG testing and diagnosis (on average 4 days (SD 1.9, range 2-11) after the onset of symptoms), all patients received information from the physical therapist who was responsible for the training. Information was given concerning the balance system, the mechanisms of vestibular rehabilitation, and the study. The patients who agreed to participate in the study were then randomly assigned to home training with or without additional physical therapy by means of sealed envelopes.

All patients received oral and written instructions concerning home exercises to be performed at least 15 minutes a day beginning on the day of inclusion and continuing for as long as any symptoms of vertigo and dysequilibrium remained. The exercise instructions were quick horizontal and vertical eye movements, fixating a stationary target while moving the head, standing with feet together and eyes closed, walking on a line, and moving the head to look to the right and left and up and down while walking. The patients were instructed to continue with each exercise as long as it was difficult to perform or provoked symptoms. All patients were also encouraged to take walks outdoors.

In addition to the home exercises, the additional physical therapy group ($n = 28$) participated in three 40-min supervised sessions during the first week and then one session per week for nine weeks,

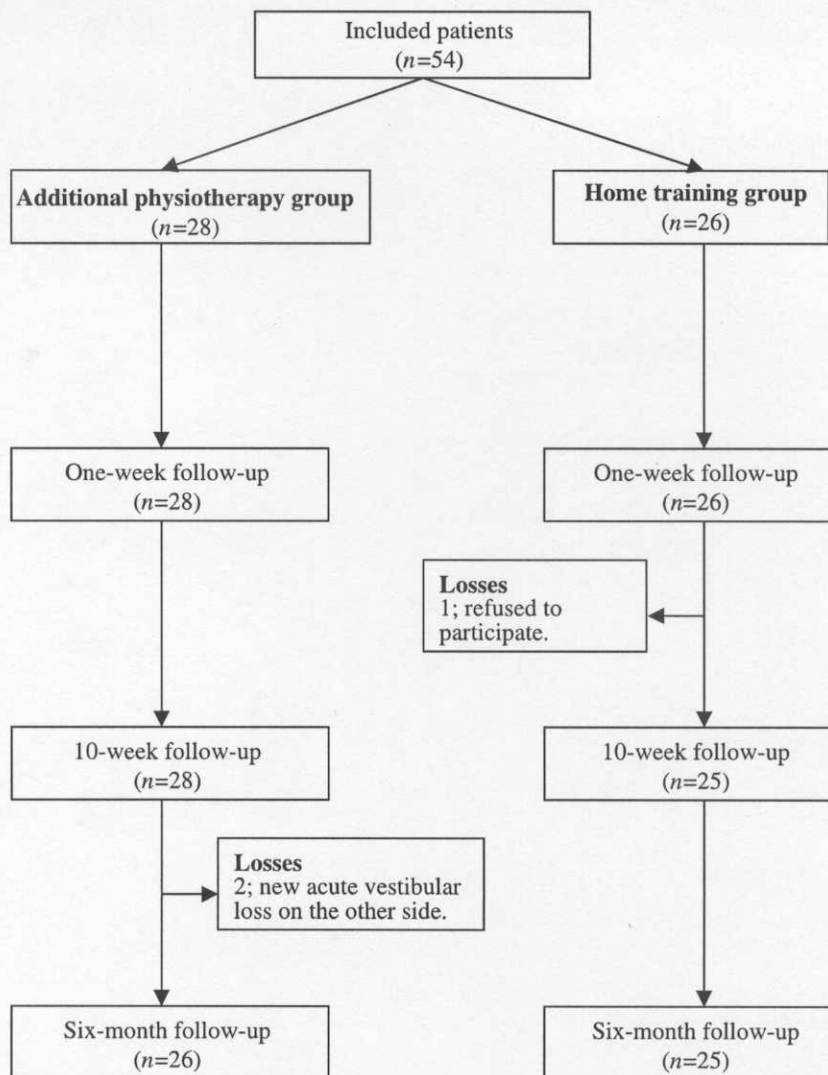


Figure 1 Flow diagram.

in total 12 sessions. The first training session was given the same day as the information and randomization. The sessions included exercises for eye and head movements, static and dynamic balance exercises like standing and walking on different firm, uneven or compliant surfaces, with combinations of eyes open or closed, movements of head, trunk and extremities and throwing and kicking balls. The exercises were designed to be challenging to the patients, so the degree of difficulty increased during the training period and different aspects of balance training were emphasized for different patients in order to individualize the exercises.

In the acute stage some patients had vestibular suppressive medication one or two days for

symptomatic relief before inclusion in the study, but during the study period no vestibular suppressants or sedatives were given.

Measured variables

On average 3 days (SD 1.6, range 1–8) after the onset of symptoms, ENG testing was performed and a diagnosis was made. At the 10-week follow-up, ENG testing was performed again. Clinical balance tests and ratings of perceived symptoms were completed at three follow-ups, one week, 10 weeks and six months after the start of home exercises. In order to remove any bias in the testing procedure, the physiotherapists testing the patients

were blinded with respect to the group to which the particular patient belonged.

ENG testing

Routine ENG testing was performed including spontaneous nystagmus and binaural bithermal caloric tests using water at 30 and 44°C to evaluate caloric function. The procedure has been described in detail elsewhere.¹⁸

Static clinical balance tests

The patients were asked to stand with their feet in three different positions in order to vary the base of support on a firm surface, and normal stance position on foam in order to distort the somatosensory input. All tests were performed first with the eyes open and then with them closed in the following order: Romberg's position with the feet together, sharpened Romberg's position with one foot in front of the other, normal standing on a 10-cm-thick foam cushion, and standing on one leg. Arms were held vertically by the sides of the body. For safety, the patients stood with a corner 50 cm behind them, and the investigator stood in front of them. In the eyes closed conditions, posture was assumed just prior to eye closure. The tasks were timed with a stopwatch until the patient moved his or her feet from the given position, opened his or her eyes on the eyes closed tests, or reached the maximum time of 30 s. Three trials were performed if a maximum of 30 s was not reached in the first or second trial, and the mean value was used for analysis. Compensatory movements of trunk, arms or the lifted leg were accepted without stopping the time-keeping, but it was stopped if the lifted foot touched the floor. Both legs were tested, and the result of the best leg was used for analysis. A similar performance of the sharpened Romberg's test and the one leg stance test has been found to have good inter-rater (ICC 0.95–0.99) and test–retest (ICC 0.73–0.93) reliability.¹⁹ Balance times on the tests decrease as age increases in healthy subjects.²⁰ Standing on foam has been found to correlate with moving platform posturography in patients with complaints of dizziness or imbalance.²¹

In Romberg's test with eyes open and eyes closed and when standing on foam with eyes open, only a few patients did not reach the maximum mean

value of 30 s at the one-week follow-up (one, four and two patients, respectively, in the three tests). At the 10-week follow-up one patient did not reach the maximum mean value when standing on foam with eyes open. At the six-month follow-up all patients reached the maximum mean value. Therefore these three tests were not used for further analysis.

Dynamic clinical balance tests

Patients performed a tandem walk of 15 steps forward and 15 steps backward at a self-chosen speed along a line 1.5 cm wide and with a colour contrasting to that of the floor. The number of correct steps was counted. A correct step was defined as a step on the line, with heel to toe not visibly separated. The mean of three trials was used for analysis. The test has been used in other studies using 10 steps,²² 15 steps²³ or 20 steps.²⁴ El-Kashlan *et al.*²⁴ used the test as one of eight clinical dynamic equilibrium tasks, combined them into a score, and found that individuals with vestibular dysfunction performed worse than normal subjects.

Interview concerning background data and rating of perceived symptoms

The patients were interviewed using a questionnaire concerning background characteristics. They reported their employment level (full time, part time, retired, on sick leave, not working for other reasons), type of work (mostly sitting, mostly standing and walking, standing and walking and lifting, heavy work), and physical exercise habits (no exercise, irregular light exercise, regular light exercise, regular fitness training, regular hard training) by responding to questions with fixed answer categories. For evaluation of their subjective symptom level the patients were asked to rate their level of perceived vertigo during movement, perceived vertigo at rest, and balance problems on a 100-mm closed Visual Analogue Scale (VAS) ranging from no symptoms (0 mm) to worst possible symptoms (100 mm). A similar scale for rating vertigo and dysequilibrium has been found to detect changes in symptoms when evaluating vestibular rehabilitation after acoustic neuroma resection¹³ and for migraine-related vestibulopathy.²⁵

Statistical analyses

The Mann–Whitney *U*-test (tied *p*-values) was used to analyse differences between groups. The Chi-square test was used to compare gender distribution between groups. Significance level: $p \leq 0.05$.

Ethics

The patients received oral and written information about the study, and were free to choose if they wanted to participate. Sometimes the patients experienced temporary sense of fatigue or mild dizziness during the ENG testing or balance tests, but otherwise the testing procedures were not unpleasant or risky.

Results

Background characteristics

Before onset of symptoms, 31 patients worked full time, 11 part time, another 11 were retired, and one was not working for other reasons. Twelve were mostly sitting at work, 11 were standing and walking, for 17 this also included lifting, and two were engaged in heavy work. Of the 42 employed patients, 36 were on sick leave at the one-week follow-up, and this was the case for one patient at the 10-week follow-up and one patient at the six-month follow-up. With regard to physical exercise habits, 38 did not exercise at all or else not regularly, and 16 engaged in regular light exercise or fitness training. Type of work and physical exercise habits did not differ between follow-ups.

The two training groups were considered comparable as there were no differences in the variables of age, time from onset of symptoms, type of work, physical exercise habits, or asymmetry of vestibular caloric response (Table 1). There was a significant unequal gender distribution between groups (Table 1). But when the results were analysed to compare results between men and women, no differences could be seen between genders.

Home training compared to additional physical therapy

The mean for reported length of home exercises in the study population was nine weeks (SD 7, range 1–26). There were no significant differences in how long the patients had been training at home with respect to training group.

No significant differences between training groups were detected in the variables of asymmetry of vestibular caloric response, clinical balance tests or subjective ratings of symptoms at the one-week, 10-week or six-month follow-ups, or when groups were compared concerning change over time (Table 2).

Discussion

No differences in results were found between the home training group with additional supervised physical therapy and the home training group without. Strupp *et al.*¹⁶ also studied patients with acute unilateral vestibular loss, but they found less sway in a physical therapy group compared to a

Table 1 Background characteristics in age, gender, time from onset and ENG asymmetry of vestibular caloric response in the additional physiotherapy group and the home training group

Variable	Additional physiotherapy group (<i>n</i> = 28)	Home training group (<i>n</i> = 26)	<i>p</i> -value
Age, years (mean (SD))	52 (12)	52 (15)	0.742
Gender, male/female	11/17	18/8	0.028
Time from onset, days (mean (SD)) ^a	3 (2)	3 (2)	0.999
ENG asymmetry of vestibular caloric response, %, (mean (SD))			
Before	80 (21)	74 (18)	0.276
10-week follow-up	48 (32)	36 (31)	0.137

^aTime from onset of symptoms to diagnosis.
ENG, electronystagmography; SD, standard deviation.

Table 2 Mean values in clinical static and dynamic balance tests and ratings of perceived symptoms at the different follow-ups and change scores in the additional physiotherapy group and the home training group

Variable	Additional physiotherapy group ^a		Home training group ^b		p-value
	Mean	(SD)	Mean	(SD)	
Sharpened Romberg's test eyes open (s)					
One-week follow-up	27.2	(5.0)	23.9	(9.9)	0.641
10-week follow-up	29.2	(3.3)	27.9	(5.5)	0.285
Six-month follow-up	29.7	(1.3)	28.9	(4.2)	0.533
Change score ^c	2.7	(5.4)	4.2	(7.5)	0.957
Sharpened Romberg's test eyes closed (s)					
One-week follow-up	4.9	(5.8)	8.2	(8.4)	0.166
10-week follow-up	12.3	(10.1)	17.2	(9.6)	0.091
Six-month follow-up	16.1	(11.2)	17.2	(11.3)	0.626
Change score ^c	11.4	(11.3)	8.8	(11.6)	0.572
Standing on foam eyes closed (s)					
One-week follow-up	17.0	(11.0)	19.2	(12.2)	0.597
10-week follow-up	29.3	(2.0)	26.7	(7.7)	0.111
Six-month follow-up	29.1	(2.3)	29.0	(5.2)	0.201
Change score ^c	11.5	(11.0)	9.1	(11.3)	0.519
Standing on one leg eyes open (s)					
One-week follow-up	26.3	(6.5)	24.4	(9.9)	0.817
10-week follow-up	29.2	(3.0)	27.4	(7.5)	0.482
Six-month follow-up	29.5	(2.7)	27.9	(7.3)	0.503
Change score ^c	2.7	(7.3)	2.8	(7.1)	0.815
Standing on one leg eyes closed (s)					
One-week follow-up	3.8	(2.3)	6.1	(7.6)	0.511
10-week follow-up	9.3	(8.6)	11.8	(10.1)	0.250
Six-month follow-up	10.8	(9.1)	12.3	(9.3)	0.370
Change score ^c	6.9	(8.2)	6.0	(7.4)	0.910
Walking forward on a line (no. of correct steps)					
One-week follow-up	14.3	(1.1)	13.8	(2.1)	0.922
10-week follow-up	14.9	(0.3)	14.7	(0.9)	0.808
Six-month follow-up	15.0	(0.1)	14.8	(0.7)	0.559
Change score ^c	0.7	(1.1)	0.7	(1.1)	0.692
Walking backward on a line (no. of correct steps)					
One-week follow-up	13.9	(1.6)	13.3	(2.6)	0.835
10-week follow-up	14.9	(0.4)	14.7	(1.1)	0.595
Six-month follow-up	14.9	(0.2)	14.6	(0.9)	0.098
Change score ^c	1.1	(1.7)	0.9	(1.7)	0.802
Visual analogue scale: Vertigo during movement (mm)					
One-week follow-up	38.2	(21.3)	33.7	(19.7)	0.483
10-week follow-up	13.4	(15.5)	12.8	(14.7)	0.993
Six-month follow-up	8.6	(12.2)	13.9	(20.5)	0.977
Change score ^c	-30.9	(24.6)	-19.2	(22.9)	0.086
Visual analogue scale: Vertigo at rest (mm)					
One-week follow-up	13.1	(12.4)	10.7	(16.2)	0.137
10-week follow-up	3.1	(4.6)	1.8	(3.4)	0.154
Six-month follow-up	8.0	(14.5)	3.2	(7.6)	0.138
Change score ^c	-5.9	(19.7)	-5.7	(14.0)	0.623
Visual analogue scale: Balance problems (mm)					
One-week follow-up	41.1	(22.7)	41.7	(24.1)	0.979
10-week follow-up	18.1	(19.7)	8.8	(11.4)	0.068
Six-month follow-up	14.2	(20.0)	9.8	(14.9)	0.357
Change score ^c	-27.5	(32.0)	-31.4	(23.1)	0.902

^an = 28 at the one-week and 10-week follow-ups. n = 26 at the six-month follow-up.

^bn = 26 at the one-week follow-up. n = 25 at the 10-week and six-month follow-ups.

^cChange score from one-week to six-month follow-up.

control group when standing on foam on a forceplate with eyes closed in a 30-day follow-up. Differences in study design might explain the difference in results compared to our study. The study by Strupp *et al.*¹⁶ included more intense training in the physical therapy group and fewer instructions about activity to the control group. They excluded all patients who recovered partial or complete vestibular function, and had a shorter follow-up compared to our study. Herdman *et al.*¹⁰ found significant improvement of visual acuity during head movements and less complaints of oscillopsia after vestibular exercises but not after placebo exercises in patients with unilateral vestibular hypofunction. Differences between this and our study that might explain the difference in results were the more intense training and different outcome measures. Furthermore, the study by Herdman *et al.*¹⁰ included some patients with unilateral loss after surgery, and time since onset of symptoms varied from 0.5 to 36 months.

Weaknesses in the study are the relatively small number of patients, and that we do not know about the real difference in training intensity between groups. The two training groups did not differ with regard to the number of weeks the patients continued the home training programme. However, no registration was done about how often the home training was performed, so it is not known if there was actually any difference in intensity between the two groups as was planned. In the additional physical therapy group, the physiotherapist could individualize the exercises for each patient, answer questions, and encourage home training. But we do not know whether that resulted in a higher intensity of training, or if the patients felt that they did not need to do the home training on the days they went to the physical therapist for training. Consequently, the lack of differences between groups might be explained by too small differences in training intensity.

Balance is a complex function, and there is no golden standard for an overall balance measure. Therefore most clinicians and researchers use a combination of tests measuring different aspects of balance. To cover the different aspects and levels of balance function during recovery we included several clinical tests of balance. Ceiling effects were seen in our study group at all follow-ups in

some of the simplest clinical tests (Romberg's test with eyes open and closed and when standing on foam with eyes open), but our first follow-up was one week after start of training, which might explain the ceiling effects in this study. These tests might still be useful during the very first days after onset of symptoms. Another three tests (the sharpened Romberg's test with eyes open and walking both forward and backward on a line) showed ceiling effects at the 10-week and six-month follow-ups. As mainly motion-provoked symptoms remain for a long period of time after acute unilateral vestibular loss,³ there is a need to evaluate more clinical balance tests during movement.

Most of the improvements seem to take place during the first weeks, but some patients in our study still had vertigo and balance problems measured by one or several tests at the 10-week and six-month follow-ups. The course of recovery for different symptoms and functions needs to be studied further to obtain increased knowledge about vestibular compensation processes. For some patients it may be that home training instructions at an early stage or no instructions at all is enough for total recovery. If so, we need to be able to identify the patients who are at risk of a poor outcome, and supply them with intensive supervised vestibular rehabilitation. Thus, predictors for outcome, predictors of the need for intensive supervised vestibular rehabilitation, and the required intensity of this training, need further investigation.

There are other aspects not measured in this study that may influence vestibular compensation and recovery. The influences of age, asymmetry of vestibular caloric response, fluctuating vestibular function, central neurological dysfunction that is undetectable by otoneurological investigation, and psychological mechanisms remain to be

Clinical message

- No significant differences in outcome with respect to balance function or perceived symptoms were found between home training with or without additional physical therapy.

investigated. Vestibular disorders and anxiety disorders are related via both somatopsychic and psychosomatic mechanisms.²⁶ Psychological factors such as, for example, avoidance of symptom-provoking activities and anxiety arousal may make vertigo, dizziness and imbalance worse and retard recovery.²⁷

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