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Efficacy of vestibular rehabilitation on chronic unilateral vestibular dysfunction

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Objective: To assess the efficacy of vestibular rehabilitation exercises on patients with chronic unilateral vestibular dysfunction.
Design: Prospective study.
Setting: Physical Medicine and Rehabilitation Clinic and Otolaryngology Clinic of a tertiary referral hospital.
Subjects: One-hundred and twenty-five patients with unilateral chronic vestibular dysfunction were included in the study.
Interventions: Eight-week, two-staged (clinic and home) vestibular rehabilitation programme with components of Cawthorne-Cooksey and Norre exercises was applied.
Main outcome measures: Dizziness Handicap Inventory (DHI) and visual analogue scale (VAS) were completed three times (at the beginning, end of the second week and end of the treatment).
Results: Data for 112 patients in the first stage and 93 patients in the second stage were evaluated because of insufficient compliance of the other patients. The mean DHI score was decreased from 50.42 ± 24.12 points to 21.21 ± 15.97 points ($p < 0.001$) at the end of first two weeks, and to 19.93 ± 19.33 points at the end of the whole treatment. The mean VAS score was decreased from 5.87 ± 2.27 to 2.02 ± 1.75 ($p < 0.001$) at the end of second week, and to 1.51 ± 1.29 at the end of eighth week. In respect to both VAS and DHI scores, improvement was noted in 67 patients (77.4%). Age, gender and disability level had no predictive value about therapy outcome.
Conclusions: There was a fast recovery in the supervised exercise session, whereas there was no significant difference in the home exercise session. These findings suggest that either supervised exercise is better than home exercise or that 10 supervised sessions are sufficient to get the end result.

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Introduction

Chronic vestibular dysfunction is often a frustrating problem for both patient and physician, and can have a tremendous impact on an individual's quality of life. Medication offers limited improvement for many patients.[1] Although vestibular neurectomy provides excellent results in patients with classic Ménière's disease, it gives poor results in patients with uncompensated vestibular neuritis and vestibular hydrops.[2] Surgical intervention may also give rise to complications such as hearing loss and facial paralysis.[3]

Vestibular habituation exercises have been recommended for these non-Ménière's patients.[3,4] Although the exercises are popular, there are only a few studies in patients with chronic unilateral vestibular dysfunction. Those studies were performed with limited cases or with a wide variety of diagnoses.[5–7] Herdman *et al*., in their review, stressed that studies were retrospective, nonrandomized, consisting of groups that were not comparable, uncontrolled studies and, although they offer interesting descriptions of the patient population, do not provide the evidence necessary to justify the use of these exercises for treatment.[8]

The purpose of this study was to assess the efficacy of vestibular rehabilitation exercises in patients with chronic unilateral vestibular dysfunction.

Methods

This prospective study was conducted in patients with uncompensated unilateral vestibular dysfunction (CUVD) in a vertigo outpatient clinic.

Patients

The diagnosis of vestibular dysfunction was based on the following:

1) Patient history of dizziness, unsteadiness and vertigo (at least six-month history of disequilibrium).
2) Clinical examination (without evidence of bilateral vestibular dysfunction, benign paroxysmal positional vertigo (BPPV), Ménière's disease and a central vestibular lesion).
3) Caloric test showing hyporesponsiveness or unresponsiveness of the horizontal canal of the affected ear. Vestibular paresis was defined as more than a 25% asymmetry between the right-side and the left-side responses.[9]
4) Magnetic resonance imaging (MRI) of the brainstem and temporal bone was used where it was needed.
5) All patients with a history of acute and recurrent vestibular dysfunction, polyneuropathy, marked decreased visual acuity or other diseases that impair mobilization were excluded. All medications were ceased for at least two weeks before the treatment.

Study design

The patients were treated with an eight-week course of a staged vestibular rehabilitation programme, with components of Cawthorne-Cooksey and Norre exercises.[10] During the first two weeks, the patient attended a series of 30- to 45-minute exercise sessions, five days a week (total 10 sessions). Subsequently, the patient continued to perform the same vestibular exercises at home independently, with a written home exercise programme and instructions, on a daily basis, for six weeks.

The patients performed the programme once a day. Each exercise was repeated five times in each session. The patients were informed about the purpose of exercises. Four groups of movements were planned:

1) Vestibulo-ocular system (days 1–3)
   a) To generate smooth-pursuit eye movement: The patients were asked to move their eyes first slowly and then fast in all directions. These eye movements were done in supine and sitting positions.
   b) To stimulate optokinetic system: The patients were asked to move their eyes quickly in horizontal and vertical directions, and then moving back to the centre point slowly.
   c) To generate saccades: The patients had to toss a ball from one hand to the other while following the ball with their eyes, in standing position.
2) The vestibulo-spinal system (days 4–7)
   a) *Supine*: Patients move their head hori-

zontally and vertically. Patients turn their body to left and right recumbent positions, and stay in each position for at least 20 seconds. Finally patients move from supine position to sitting and then to supine position again.

   b) *Sitting*: Patients were instructed to turn their head in horizontal and vertical directions with eyes fixating on a point and with eyes closed. Patients had to move their trunk anteriorly to put a little object on the floor, with rightward and leftward flexion. Finally they had to move from sitting position to standing, and than sitting.

3) The somatosensory systems (days 8–10)
   a) *Standing*: Patients stand, with their feet apart, close together, in tandem, on one leg, with their eyes open and closed. Under these different conditions they had to move their trunk in horizontal and vertical directions. Finally the patients did these exercises on a foam exercise mat.
   b) *Walking*: Patients were instructed to walk, forward, backward, sideways, and along a line, on heels and tiptoes, with their eyes open and closed. Patients then walked with their head turned to the right and left, as well as flexed and extended. Finally the patients performed these same exercises on a foam exercise mat and on ramps.

4) Cervico-ocular reflex (days 8–10)
   Patients were seated on a rotating chair while fixating a point in front of them. They were instructed to move their trunk while keeping their head position constant.

Informed consent were given by all the patients. All patients were examined on the 1st, 15th and 60th days. The Dizziness Handicap Inventory (DHI) and visual analogue scale (VAS) was completed with examination. These were used to quantify the effects of the vestibular exercises on recovery. The Dizziness Handicap Inventory, a 25-item self-report questionnaire with three rationally derived subscales, was designed to measure functional, emotional, and physical disability associated with vestibular disturbance.[11] In addition, the final results of the treatment were evaluated according to change of VAS and DHI scores. For *complete improvement*, the VAS score is 0 and DHI score is less than 10; for *improvement*, the score is less than at the beginning; for the *same*, the score is the same as at the beginning; and for *deterioration*, the score is higher than at the beginning. For the DHI, a score plus or minus two points of the beginning score was regarded as the same or no change.

The patients were divided into groups in order to study the effect of age, gender and disability level on therapy. Age 40 was the cut-off point for evaluating the effect of age; 5 points was the cut-off for VAS and 50 was for the DHI.

Table 1 Comparison of DHI scores and VAS

	1 day Mean (median) ± SD Min/max	15 day Mean (median) ± SD Min/max	45 day Mean (median) ± SD Min/max
DHI (Emotional)	14.07(12) ± 9.95 0/36	4.48(4) ± 5.63 0/28	4.19(2) ± 6.87 0/32
DHI (Functional)	20.16(20) ± 10.53 0/36	8.76(8) ± 7.47 0/32	6.83(6) ± 6.52 0/32
DHI (Physical)	16.42(16) ± 7.58 0/28	7.98(8) ± 6.03 0/26	8.92(6) ± 8.72 0/30
DHI (Total)	50.42(48) ± 24.124 6/96	21.21(20) ± 15.97 0/86	19.93(14) ± 19.33 0/92
VAS	5.87(5) ± 2.27 0/10	2.02(2) ± 1.75 0/8	1.51(1) ± 1.29 0/9

DHI, Dizziness Handicap Inventory; VAS, visual analogue scale.

Patients who did not come to the regular sessions (missed three or more), did not continue the home exercise or missed more than 30% of the therapy were excluded from the study. During the training period in the hospital, compliance was monitored by a physician. Home exercises were monitored with a chart that was filled in every day by the patients.

The differences between prerehabilitation and postrehabilitation scores of VAS and DHI were analysed with the Wilcoxon signed rank sum test. Prerehabilitation and postrehabilitation differences between age and gender groups were analysed using the Kruskal–Wallis test.

Results

One-hundred and twenty-five patients were initially included in the study. Thirty-two of these 125 patients showed insufficient compliance and were excluded. Nine patients completed the first session of exercises but did not come to following sessions for unknown reasons. Four patients missed three or more of supervised sessions (one due to unrelated illness, one due to nausea, one due to transport difficulties, one due to business life). Seven patients did not fill in the chart regularly at home. Thirteen patients did not come to control at the end of therapy. As a result, the data of 112 patients (77 (68.8%) women and 35 men; mean age 44.83–14.16 years; median 44, range 17–75) were analysed statistically at the end of the first stage. At the end of the second stage, 93 patients (61 (65.6%) women and 32 men; mean age 44.08–14.30 years; median 44, range 17–75) were analysed statistically. The percentage of improvement was evaluated with the data of final sample, including 93 patients.

Mean symptom duration was 15.76 ± 7.67 months (6–46 months) for 112 patients.

At the beginning, the mean DHI score was

Table 2 Treatment efficacy according to gender. There is no statistical difference between two groups on any score

	1 day Mean (median) ± SD Min/max	15 day Mean (median) ± SD Min/max	45 day Mean (median) ± SD Min/max
DHI (Emotional)			
Female	15.03(12) ± 9,75 0/36	4.00(4) ± 9.91 0/28	3.80(2) ± 6.41 0/32
Male	11.94(12) ± 10,20 0/32	5.54(4) ± 6.93 0/28	4.93(2) ± 7.73 0/32
DHI (Functional)			
Female	22.31(24) ± 9.60 0/36	9.27(8) ± 7.15 0/32	6.75(6) ± 6.16 0/24
Male	15.42(14) ± 11.06 0/36	7.65(4) ± 8.12 0/32	7.00(4) ± 7.25 0/32
DHI (Physical)			
Female	18.44(20) ± 6.61 2/28	8.41(8) ± 5.55 0/22	9.34(6) ± 8.59 0/30
Male	12.00(12) ± 7.77 0/26	7.02(4) ± 6.96 0/26	8.12(4) ± 9.05 0/30
DHI (Total)			
Female	55.53(54) ± 21.67 10/96	21.68(20) ± 13.89 0/64	19.93(14) ± 18.29 0/86
Male	39.20(32) ± 25.69 0/92	20.17(18) ± 19.96 2/86	19.93(16) ± 21.50 0/92
VAS			
Female	5.05(5) ± 2.31 0/10	2.07(2) 1.81 0/ ± 8	1.27(1) ± 0.96 0/5
Male	4.48(5) ± 2.18 0/10	1.91(2) ± 1.63 0/7	1.96(2) ± 1.69 0/9

50.42 ± 24.12. The average decrease in DHI score was 29.21 points at the end of first two weeks ($p < 0.001$), and 30.49 points at the end of the whole treatment (Table 1). There were significant differences between pretreatment versus the 15th day in respect to DHI subscores ($p < 0.001$).

The mean VAS score was 5.87 ± 2.27 at the beginning and it decreased significantly during the course of the treatment (second week 2.02 ± 1.75, $p < 0.001$, and eighth week 1.51 ± 1.29). There was no significant difference in VAS and DHI scores between the second week and end of the treatment.

With respect to VAS score, cure was noted in 45 patients (48.3%), improvement in 27 patients (29.0%), no change in nine patients (9.6%) and deterioration in 12 patients (12.9%), after vestibular rehabilitation therapy.

With respect to DHI score, cure was noted in 36 patients (38.7%), improvement in 36 patients (38.7%), no change in 15 patients (16.1%) and deterioration in six patients (6.4%).

There was no statistical difference between age, gender and disability level groups in response to therapy (Tables 2–5).

Discussion

In our study, nearly 80% of the patients have showed improvement with respect to both DHI and VAS scores. Cure was noted in 38.7% and 48.3% of patients with respect to DHI and VAS scores respectively. A fast recovery was found in the supervised session. There was no significant difference in VAS and total DHI scores between the second week and end of the treatment. Age, gender and pretreatment disability level made no difference to therapy outcome.

Symptoms due to acute vestibular disorders may disappear even without treatment within 2–3

Table 3 Evaluation of treatment according to age. There is no statistical difference between two groups on any score

	1 day Mean (median) ± SD Min/max	15 day Mean (median) ± SD Min/max	45 day Mean (median) ± SD Min/max
DHI (Emotional)			
Age <40	14.13(12) ± 9.10 0/34	4.26(4) ± 4.50 0/24	3.53(2) ± 5.22 0/20
Age >40	14.03(12) ± 10.55 0/36	4.62(4) ± 6.30 0/28	4.66(1) ± 7.87 0/32
DHI (Functional)			
Age <40	17.64(16) ± 10.32 0/36	7.64(6) ± 7.72 0/32	5.79(6) ± 4.85 0/20
Age >40	21.85(24) ± 10.40 0/36	9.52(8) ± 7.26 0/32	7.59(6) ± 7.45 0/32
DHI (Physical)			
Age <40	14.84(16) ± 7.70 0/28	8.20(8) ± 6.01 0/26	9.81(6) ± 9.18 0/30
Age >40	17.49(18) ± 9.07 0/28	4.26(4) ± 4.50 0/24	4.26(4) ± 4.50 0/24
DHI (Total)			
Age <40	46.48(48) ± 22.28 8/90	19.55(18) ± 15.57 2/54	16.97(10) ± 15.70 0/70
Age >40	53.07(54) ± 25.09 6/96	22.32(20) ± 16.86 0/86	22.07(18) ± 21.47 0/92
VAS			
Age <40	4.75(5) ± 1.70 2/9	1.97(2) ± 1.77 0/8	1.66(2) ± 0.95 0/5
Age >40	4.95(5) ± 2.60 0/10	2.06(2) ± 1.74 0/8	1.4(1) ± 1.49 0/9

months, although vestibular paralysis persists. The vestibulo-ocular, somatosensory systems can be trained by daily activities, such as simply opening their eyes, looking and walking around.

Vestibular rehabilitation is an exercise-based approach designed to maximize central nervous system compensation for vestibular pathology.[12,13] The exercises are supposed to accelerate and improve central compensation via the mechanisms of habituation training, which enhance adaptation of the vestibulo-ocular reflex and vestibulo-spinal reflexes as well as increase substitution.[14]

Our data agree with previous studies, which demonstrated that vestibular exercises can improve vestibular symptoms in patients with chronic unilateral vestibular failure.[1,15,16] After two weeks of supervised outpatient exercise programme, a fast recovery was found in the patients. There was no significant difference in VAS and total DHI scores between the second week and end of the treatment. This observation leads to three different conclusions. First, our rehabilitation programme showed maximum effect after the first two weeks; second, there was no significant effect of the home programme on the clinical course of the compensation; or third, patients did not follow the programme as instructed. There are two publications that sup-

Clinical messages

- Our findings suggest that a short period of supervised vestibular exercises decrease symptoms and disability in patients with a unilateral peripheral vestibular lesion.
- Since there is no additional improvement with home exercises, studies on the duration and place (inpatient/outpatient) of therapy are necessary.

Table 4 Evaluation of treatment according to DHI scores. There is no statistical difference between two groups on any score

	1 day Mean (median) ± SD Min/max	15 day Mean (median) ± SD Min/max	45 day Mean (median) ± SD Min/max
DHI (Emotional)			
DHI (total) <50	8.10(6) ± 6.60 0/24	2.70(0) ± 4.48 0/24	2.20(0) ± 3.94 0/20
DHI (total) >50	20.25(20) ± 9.05 8/36	6.32(6) ± 6.13 0/28	6.40(4) ± 8.62 0/32
DHI (Functional)			
DHI (total) <50	11.65(12) ± 6.17 0/24	5.05(4) ± 4.81 0/28	5.02(4) ± 4.36 0/22
DHI (total) >50	28.98(28) ± 5.73 12/36	12.61(12) ± 7.82 0/32	8.86(8) ± 7.86 0/32
DHI (Physical)			
DHI (total) <50	11.26(12) ± 6.20 0/26	5.89(4) ± 5.49 0/22	6.24(4) ± 7.92 0/28
DHI (total) >50	21.78(22) ± 4.56 0/28	10.14(8) ± 5.84 0/26	11.90(10) ± 8.69 0/30
DHI (Total)			
DHI (total) <50	30.49(32) ± 13.86 10/48	13.75(12) ± 11.58 0/52	13.42(8) ± 13.64 0/50
DHI (total) >50	70.83(68) ± 13.24 52/96	28.94(26) ± 16.30 2/86	27.18(22) ± 22.14 0/92
VAS			
DHI (total) <50	4.08(4) ± 2.10 0/10	1.68(2) 1.77 0/8	1.36(1) ± 0.95 0/5
DHI (total) >50	5.69(5) ± 2.17 1/10	2.38(2) ± 1.67 0/7	1.68(1.5) ± 1.59 0/9

Table 5 Evaluation of treatment according to VAS scores. There is no statistical difference between two groups on any score

	1 day Mean (median) ± SD Min/max	15 day Mean (median) ± SD Min/max	45 day Mean (median) ± SD Min/max
DHI (Emotional)			
VAS <5	12.15(10) ± 8.97 0/34	3.82(2) ± 5.30 0/28	3.51(2) ± 6.23 0/32
VAS >5	18.66(16) ± 10.79 0/36	6.06(6) ± 6.15 0/28	6.26(6) ± 8.36 0/32
DHI (Functional)			
VAS <5	17.67(16) ± 10.47 0/36	7.51(6) ± 7.33 0/32	6.82(6) ± 6.59 0/32
VAS >5	26.13(28) ± 8.03 8/36	11.75(12) ± 7.03 0/32	6.87(6) ± 6.43 0/24
DHI (Physical)			
VAS <5	14.86(16) ± 7.13 0/28	7.57(6) ± 6.19 0/26	8.45(4) ± 9.07 0/30
VAS <5	20.18(22) ± 7.40 2/28	8.97(8) ± 5.59 0/22	10.34(10) ± 7.57 0/30
DHI (Total)			
VAS <5	44.98(44) ± 23.22 6/92	18.48(18) ± 16.22 0/86	18.77(10) ± 19.29 0/92
VAS >5	63.45(62) ± 21.33 18/96	26.54(24) ± 14.20 0/64	23.47(20) ± 19.44 2/86
VAS			
VAS <5	3.72(4) ± 1.47 0/9	1.74(2) 1.63 0/8	1.51(1) ± 1.40 0/9
VAS >5	7.63(8) ± 1.24 6/10	2.69(2) ± 1.86 0/8	1.52(2) ± 0.94 0/3

port the second conclusion.[16,17] Szturm *et al.* compared an outpatient plus home exercises programme with home exercises alone, and found that the first was significantly better in standing balance performance.[16] Our study is not a randomized controlled study, and therefore it cannot be concluded absolutely that the treatment is effective, as it could possibly simply be the extra attention. The physical subscore of the DHI deteriorated in our patients between the 15th and 45th days. Interestingly, while patients were becoming physically worse, they were functionally and emotionally better. We thought that this could be a result of increasing activity. Black *et al.* also reported that physical exercises encourage patients in doing daily living activities.[18]

In retrospective studies, vestibular rehabilitation efficacy ranged from 66%[19] to 75%[15] and to 85%.[5] In a prospective study, 60% of patients showed objective improvement of balance function; 25% of patients improved to normal.[20] All of these studies were performed in patients with a wide variety of diagnoses. In patients with chronic vestibular dysfunction, it was noted that 59% of patients showed a dramatic improvement after their vestibular symptoms no longer caused any restriction in their lifestyles.[4] An additional 23% of patients noted considerable improvement, but had persistent symptoms that continued to restrict their activities.

In our study, nearly 80% of patients showed improvement with respect to both DHI and VAS scores. Cure was 38.7% and 48.3% with respect to DHI and VAS scores respectively. These findings suggest that vestibular rehabilitation therapy gives excellent results in patients with unilateral vestibular dysfunction.

The results of this study support those of previous studies, which reported that age makes no difference on therapy outcome.[5,15,21] Our results are inconsistent with the findings of one study[5], reporting that pretreatment disability level has a negative influence on therapy outcome. We could not find any study on the effect of gender on therapy outcome.

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