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Balance improvement in patients with benign paroxysmal positional vertigo

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Objective: To investigate the effect of an additional vestibular stimulated exercise programme on balance for patients with benign paroxysmal positional vertigo.
Design: Randomized controlled trial.
Setting: Medical centre.
Subjects: Twenty-six subjects with benign paroxysmal positional vertigo involving the unilateral posterior semicircular canal.
Interventions: Subjects were randomized into experimental or control groups. Thirteen subjects in the experimental group received the canalith repositioning manoeuvre and vestibular stimulated exercise training three times a week for four weeks. Thirteen subjects in the control group received only the canalith repositioning manoeuvre.
Main measures: Static balance tests, tandem walk test, Dynamic Gait Index and subjective rating of the intensity of vertigo were measured at baseline, two-week and four-week assessments.
Results: Compared with the control group, subjects in the experimental group demonstrated a statistically significant improvement in single leg stance with eyes closed at the two-week assessment ($P < 0.05$). Furthermore, stance on foam surface with eyes closed, single-leg stance with eyes closed, and Dynamic Gait Index at the four-week assessment were also significantly improved ($P < 0.05$).
Conclusion: The present study demonstrated that additional exercise training, which emphasizes vestibular stimulation, can improve balance ability and functional gait performance among patients with benign paroxysmal positional vertigo who had already undergone the canalith repositioning manoeuvre.

Introduction

Benign paroxysmal positional vertigo is considered to be the most common peripheral vestibular disorder.[1] Most patients with benign paroxysmal positional vertigo (90.2%) have involvement of the posterior semicircular canal.[2] According to previous studies, patients with benign paroxysmal positional vertigo have shown impaired balance ability after a provocative head movement.[3] A significant increase in body sway has also been noted both in the lateral and antero-posterior planes under both eyes open and eyes

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closed test.[4] In addition, patients with benign paroxysmal positional vertigo showed increased postural sway specifically under conditions where there were altered proprioceptive inputs combined with altered or deprived visual inputs.[5,6] The lack of accurate vestibular information from one side may cause ineffective sensory organization and abnormal vestibulospinal output, which results in increased sway when both visual and proprioceptive inputs are altered.[7] Decreased dynamic postural control contributes to functional limitation in people with vestibular disorders.[8] Impaired balance is also related to the increase of falls, fractures and other fall-related injuries.[9] It is therefore clear that the balance impairment in patients with benign paroxysmal positional vertigo needs to be considered and managed.

The canalith repositioning manoeuvre is the most common clinical treatment for patients with benign paroxysmal positional vertigo.[10] It is a safe and effective treatment to resolve abnormal positional vertigo and nystagmus.[11–14] However, patients with benign paroxysmal positional vertigo after treatment with the canalith repositioning manoeuvre may still demonstrate insufficient postural stability control.[5] Therefore, specific training has been suggested for patients with benign paroxysmal positional vertigo to improve their balance ability.[5,15]

Vestibular rehabilitation for patients with benign paroxysmal positional vertigo has been shown to be effective in improving vertigo and nystagmus.[16,17] However, the effect of vestibular rehabilitation on balance for patients with benign paroxysmal positional vertigo has not been investigated substantially. The purpose of our study was to investigate the effect of additional vestibular stimulated exercise training on balance for patients with benign paroxysmal positional vertigo who had already undergone the canalith repositioning manoeuvre.

Methods

Subjects

Patients who had just suffered their first attack of benign paroxysmal positional vertigo involving unilateral posterior semicircular canal and had been diagnosed by neurologists were recruited from Taipei Veterans General Hospital neurological clinics. The diagnostic criteria for benign paroxysmal positional vertigo involving posterior semicircular canal in the present study were the presence of positional vertigo and a typical torsional upbeating nystagmus provoked by the Dix–Hallpike test.[18] For the provoked nystagmus, it was defined as delayed onset (2–40 seconds), transitory (<60 seconds), and reversed when the patient resumed the original sitting position.

Subjects in this study underwent clinical examinations consisting of medical history, oculomotor examination with an infrared video recording system, and a caloric test, all carried out by a neurologist. The oculomotor examination included saccade and pursuit tests and was used to differentiate central from peripheral vestibular lesions. The caloric test with bi-thermal air stimulation was used to evaluate peripheral vestibular hypofunction. The purpose of the physical examinations was to confirm the diagnosis and validate the homogeneity of all subjects who took part in our study.

The present study excluded patients with benign paroxysmal positional vertigo involving anterior or horizontal canal and other vestibular disorders including Ménière's disease, vestibular neuritis, labyrinthitis and peripheral vestibular loss. Patients with neurological pathology, proprioceptive impairment, cardiovascular diseases or orthopaedic problems (osteoarthritis of knee or lower extremity deformity) were excluded to eliminate confounding factors affecting balance performance. Patients who combined benign paroxysmal positional vertigo with cervical neurological symptoms, a limited range of movement of the neck, and cervical spine instability were also excluded because both the Dix–Hallpike test and the canalith repositioning manoeuvre involve neck torsion and extension, which may place strain on the spine.[19]

Procedures

The study protocol was reviewed and approved by the Institutional Review Board of the Taipei Veterans General Hospital. Fifty-seven

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patients were diagnosed with benign paroxysmal positional vertigo by neurologists according to the characteristic clinical symptoms. After physical examination and initial assessment, 31 patients were excluded based on the exclusion criteria. Twenty-six subjects were eligible to participate and these subjects gave informed consents. Subjects were then randomly assigned to either the experimental group or the control group by an independent person who picked one of the sealed envelopes 30 minutes before the start of the intervention. The 13 subjects in the experimental group received the canalith repositioning manoeuvre at one or two sessions in the first two weeks and vestibular stimulated exercise training three times a week for the whole of four weeks. The other 13 subjects in the control group received only the canalith repositioning manoeuvre at one or two sessions over the first two weeks. All subjects were evaluated at baseline, two-week and four-week assessments (Figure 1). All of the measurements were executed by one evaluator who was blinded to the subjects' group assignment.

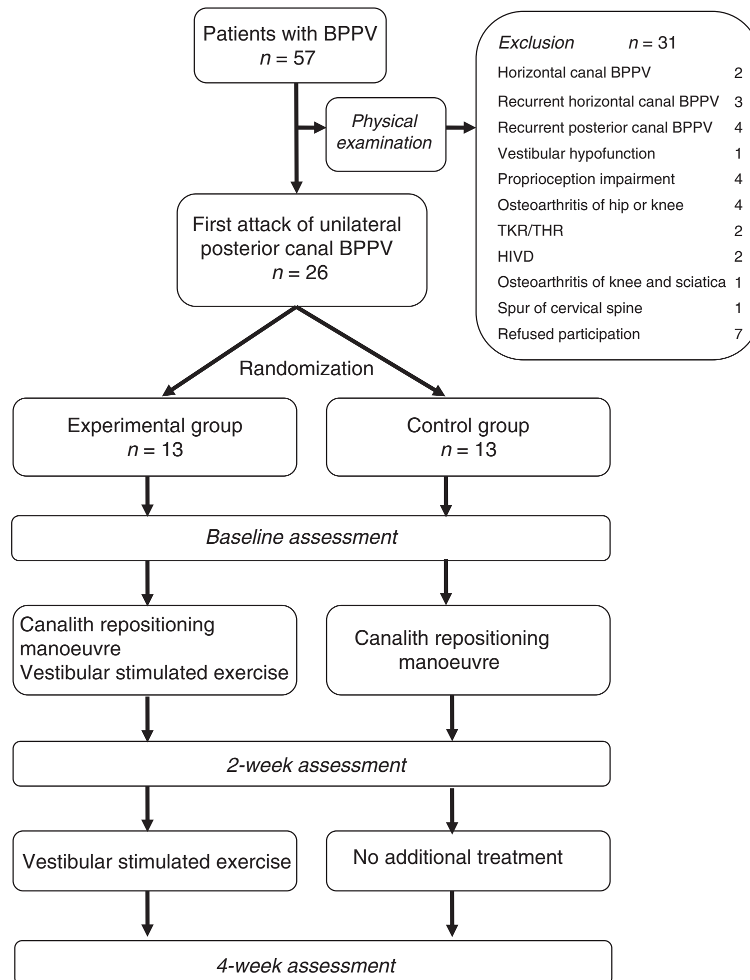

Figure 1 Flow diagram of the study. BPPV, benign paroxysmal positional vertigo; TKR, total knee replacement; THR, total hip replacement; HIVD, herniated intervertebral disc.

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Interventions

All interventions in the control group and experimental group were executed by the same physical therapist who had three years of experience of vestibular rehabilitation. The canalith repositioning manoeuvre designed by Epley is a specific treatment for patients with posterior canal benign paroxysmal positional vertigo based on the canalithiasis theory.[10] In our study, all subjects in both groups received the modified Epley manoeuvre over either one or two sessions during a two-week period. If the subject still showed a positive Dix–Hallpike response after the first canalith repositioning manoeuvre, the subject then received a second canalith repositioning manoeuvre. Prior to each treatment, it was explained to the subjects that the treatment might provoke vertigo and nausea and they were asked to relax their neck muscles to prevent neck soreness. The physical therapist changed the patient's body posture and head position to allow any floating debris to move along the semicircular canal back into the utricle.

The treatment was performed as follows. First, while in the sitting position, the patient's head was turned to the affected side at 45 degrees. Second, the patient was moved rapidly into the supine position with the head at 105 degrees backward and this position was maintained for 1–2 minutes until nystagmus and vertigo ceased. Characteristic nystagmus was observed with Frenzel glasses. Third, the patient then slowly rotated their head to the unaffected side at 45 degrees and this position was maintained for 1–2 minutes until nystagmus and vertigo ceased. Fourth, the patient rotated their trunk 90 degrees to lie on the unaffected side and this position was maintained for 1–2 minutes until nystagmus and vertigo ceased. Finally, the patient was slowly returned to the sitting position.[10,20] All subjects were instructed to keep their head upright, not to bend over and to sleep in a sitting up position for the first 48 hours after the manoeuvre.

Subjects in the experimental group received an additional 40 minutes vestibular stimulated exercise programme, three times a week for four weeks. Each patient was treated by the same skilled physical therapist. The exercise programme aimed to stimulate the vestibular system. The exercises included oculomotor exercises, repeated head movement exercises, balance training exercise and functional activities. The goal of the vestibular stimulated exercises was to improve the balance ability of the patients with benign paroxysmal positional vertigo and it also addressed improvements in other impairments such as vertigo and gaze instability. The oculomotor exercises were designed to improve gaze stability and visual–vestibular interaction. The repeated head movement exercises were used to habituate vestibular responses. The balance training exercise emphasized the use of the vestibular system inputs by altering visual or proprioceptive sensory inputs. The functional activities were to facilitate the vestibulospinal response, help regain balance and improve physical function through exercises that took place during walking in different environments.

The difficulties of the task in each session were different for each patient according to the balance performance or the tolerance to vestibular stimulus. The approaches used to increase task difficulty were: (1) a change from treatment with eyes open to with eyes closed; (2) a change from treatment on a firm surface to on an uneven surface; (3) a change from treatment at a comfortable speed to at an increased or altered speed; (4) a change from treatment in a straight line to in an altered direction; or (5) a change from treatment with a wide base of support to with a narrower base of support.[21] If subjects complained of increased vertigo or mild nausea during the treatment process, they then took a rest until they felt comfortable. Vomiting or significant nausea were reasons for modifying the exercises.[21]

Outcome measures

Subjects received assessments at baseline, two-week and four-week assessments. At each assessment, the order of the evaluations was randomized.

Static balance tests

Balance impairment in the patients with benign paroxysmal positional vertigo was measured by the Balance Master System (Neurocom International, Inc., USA). The subjects stood on the dual force plates with a standard foot

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position and faced the screen. Static balance was measured as sway velocity under two conditions: stance on foam surface and single-leg stance. The single-leg stance was tested using the dominant leg. Each condition was performed with the eyes open and then with the eyes closed. For safety, two assistants stood by in case the patients lost their balance. All patients were instructed to stand upright as steadily as possible. Each test consisted of three trials, each lasting for 10 seconds. Sway velocity was the ratio of distance travelled by the centre of gravity during the time of the trial (10 seconds). A lower sway velocity indicated better balance stability. If the subject lost their balance during a test, the trial was stopped and the sway velocity was recorded as 12.0 (the maximal score in the system).

Dynamic balance test

Dynamic balance was measured as the end sway velocity in a tandem walk test by the Balance Master System. Subjects were instructed to stand heel-to-toe steadily at the starting position. When the 'Go' instruction appeared on the screen, subjects did a tandem walk along a 153-cm straight line on the force plates as quickly as possible and stopping still at the end of the force plates. The test consisted of three trials, each lasting for 10 seconds. End sway velocity (degrees/second) was measured when the forward progression had stopped. The sway velocity was recorded as 12.0 if a subject stepped off the force plate or improperly positioned themselves.

Dynamic Gait Index

The functional gait scale consists of eight tasks including gait on a level surface, change in gait speed, gait with horizontal head turns, gait with vertical head turns, pivot turning, stepping over an obstacle, stepping around an obstacle, and ascending and descending stairs. There was a 4-point ordinal scale for each item with a total score of 24 points.[9]

Subjective rating intensity of vertigo

Subjects rated their intensity of vertigo using a 10-cm visual analogue scale ranging from no symptoms (0 cm) to the worst possible symptoms (10 cm).[22]

Intra-rater reliability of the measurements

There was a lack of studies of intra-rater reliability of the static and dynamic balance ability measured by the Balance Master System and the Dynamic Gait Index in patients with benign paroxysmal positional vertigo. Therefore, a preliminary study was carried out to examine the within-day intra-rater reliability of these measures. All tests were carried out twice. Retest was performed at least 1 hour after the first test on the same day. The order of the measures was randomized.

Statistics

All data were analysed using SPSS version 10.0 software. Descriptive statistics were used to characterize age, gender, lesion side, dominant side, duration of symptoms, and regular exercise habits of the subjects in both groups. To elucidate the within-group effect, repeated measure analysis of variance was used. To analyse the between-group effect, multivariate analysis of variance was used.

The sway velocities of patients with benign paroxysmal positional vertigo in each group were also compared to age-matched norm values under different conditions. Patients with less sway velocity than age-matched norm value indicated that their balance control was within normal range. A χ^2 test was used to determine whether the number of patients with normal balance control in the experimental group differed from that in the control group. McNemar's test was used to determine the within-group change in the number of patients with normal balance control in each group. Statistical significance was set at $P < 0.05$.

Results

Intra-rater reliability of the measurements

Twenty-one patients with unilateral posterior canal benign paroxysmal positional vertigo volunteered to participate in the preliminary study.

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The patients averaged 54.14 ± 10.94 years old and 11 patients (55%) were found to be affected in the right inner ear. Our results showed good to excellent intra-rater reliabilities for static and dynamic balance measurements (ICC = 0.87–0.99) in patients with benign paroxysmal positional vertigo. Good intra-rater reliability ($k = 0.83$) for the Dynamic Gait Index was also found in patients with benign paroxysmal positional vertigo.

Basic characteristics

Twenty-six patients with unilateral posterior semicircular benign paroxysmal positional vertigo were recruited for this clinical trial with 13 patients (mean age: 56.42 ± 11.42 years old) in the experimental group and 13 patients (mean age: 53.93 ± 9.97 years old) in the control group. The basic characteristics of patients in each group are presented in Table 1. No significant differences were found for the basic characteristics between groups.

After the first session of canalith repositioning manoeuvre, three subjects in the control group and four subjects in the experimental group demonstrated a positive Dix–Hallpike response. These seven subjects received a second canalith repositioning manoeuvre. After receiving either one or two sessions of the canalith repositioning manoeuvre, 88.5% (23/26) of all patients showed no positional vertigo and nystagmus during the Dix–Hallpike test. The exceptions were one subject in the control group and two subjects in the experimental group. Patients in the experimental group participated in vestibular stimulated exercise training for an average of 9.9 out of 12 sessions (82.7%).

Table 1 Baseline characteristics of subjects

Characteristics	Experimental group ($n = 13$)	Control group ($n = 13$)
Age (years), mean (SD)	56.42 (11.42)	53.93 (9.97)
No. of patients in each age level		
Age 21–40	1 (8%)	1 (8%)
Age 41–60	8 (62%)	10 (76%)
Age 61–80	4 (30%)	2 (16%)
Gender, *n* (%)		
Female	8 (62%)	7 (54%)
Male	5 (38%)	6 (46%)
Lesion side, *n* (%)		
Right	8 (62%)	7 (54%)
Left	5 (38%)	6 (46%)
Dominant side, *n* (%)		
Right	13 (100%)	13 (100%)
Left	0 (0%)	0 (0%)
Duration of symptoms (days), mean (SD)	26.00 (19.38)	19.46 (16.72)
Number of subjects taking regular exercise, *n* (%)	7 (54%)	6 (46%)

SD, standard deviation.

Static and dynamic balance measures

At baseline, sway velocity of static balance for each condition did not differ significantly between the groups. Patients in the experimental group showed significantly less sway velocity for stance on foam surface with eyes closed ($P < 0.01$) and single-leg stance with eyes closed ($P < 0.01$) at the two-week assessment. The improvements were also statistically significant at the four-week assessment ($P < 0.01$). They also showed significantly less sway velocity for single-leg stance with eyes open ($P < 0.05$) at the four-week assessment. Patients in the control group showed a significantly lower sway velocity for stance on foam surface with eyes closed at the two-week assessment ($P < 0.05$) and single-leg stance with eyes closed at the four-week assessment ($P < 0.05$). Compared with the control group, patients in the experimental group demonstrated significantly less sway velocity in the single-leg stance with eyes closed at the two-week ($P < 0.05$) and four-week assessments ($P < 0.05$) as well as stance on foam surface with eyes closed at the four-week assessment ($P < 0.05$). No significant differences within each group or between groups were found for stance on foam surface with eyes open and the tandem walk test (Table 2).

Comparison with age-matched norm values

After two weeks or four weeks, the number of patients with normal sway velocity in the control group had not changed significantly. In the experimental group, more patients fell into the normal sway velocity category especially for the stance on foam surface with eyes closed at the four-week assessment ($P < 0.05$) and for single leg stance with eyes closed at the 2-week ($P < 0.05$) and

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4-week assessments ($P < 0.05$). The number of patients with normal sway velocity in the experimental group were also significantly more than that in the control group for stance on foam surface with eyes closed test ($P < 0.05$) or the single-leg stance with eyes closed test ($P < 0.05$) (Table 3).

Dynamic Gait Index

Patients in both groups significantly improved their Dynamic Gait Index scores at the two-week and four-week assessments ($P < 0.01$). Patients in the experimental group also demonstrated significantly greater scores on Dynamic Gait Index than those in the control group at the four-week assessment ($P < 0.05$) (Table 2).

Intensity of vertigo

There were no significant differences between groups for visual analogue score at baseline. Patients with benign paroxysmal positional

Table 2 Main measures for subjects in the experimental group and control group at baseline, two-week, and four-week assessments

Outcome variable Mean (SD)	Experimental group ($n = 13$)			Control group ($n = 13$)		
	Baseline	2-week	4-week	Baseline	2-week	4-week
Static balance (sway velocity)						
Stance on foam surface (degree/s)						
Eyes open	0.57 (0.25)	0.48 (0.16)	0.44 (0.15)	0.56 (0.25)	0.49 (0.28)	0.44 (0.17)
Eyes closed	2.43 (1.62)	1.52 (0.49)**	1.27 (0.39)**,†	2.32 (1.09)	1.76 (0.73)*	1.94 (0.77)
Single-leg stance (degree/s)						
Eyes open	0.68 (0.28)	0.61 (0.17)	0.52 (0.16)*	0.75 (0.38)	0.70 (0.41)	0.58 (0.16)
Eyes closed	10.16 (2.67)	5.45 (4.47)**,†	5.59 (4.88)**,†	10.72 (2.59)	10.42 (3.09)	9.43 (3.49)*
Dynamic balance (sway velocity)						
Tandem walk (degree/s)	4.58 (1.75)	3.67 (1.43)	3.56 (0.73)	5.13 (1.54)	3.91 (1.52)	3.90 (1.39)
DGI (points)	19.2 (2.3)	22.5 (1.5)**	23.5 (0.7)**,†	19.8 (2.8)	21.9 (1.60)**	22.5 (1.40)**
VAS (cm) of vertigo	5.3 (1.7)	2.0 (1.6)**	1.1 (1.2)**	5.1 (1.6)	2.0 (1.3)**	1.0 (1.0)**

SD, standard deviation; DGI: Dynamic Gait Index; VAS, visual analogue scale.
*Significant difference within group compared to baseline, $P < 0.05$.
**Significant difference within group compared to baseline, $P < 0.01$.
†Significant difference between groups, $P < 0.05$.

Table 3 Numbers (%) of subjects with normal sway velocity in the experimental group and control group at baseline, two-week and four-week assessments

Outcome variable	Experimental group ($n = 13$)			Control group ($n = 13$)		
	Baseline	2-week	4-week	Baseline	2-week	4-week
Static balance						
Stance on foam surface						
Eyes open	9 (69%)	12 (92%)	12 (92%)	9 (69%)	11 (84%)	12 (92%)
Eyes closed	4 (31%)	7 (54%)	11(84%)*,†	5 (38%)	5 (38%)	5 (38%)
Single-leg stance						
Eyes open	12 (92%)	13 (100%)	13 (100%)	10 (77%)	11 (84%)	13 (100%)
Eyes closed	0 (0%)	6 (46%)*,†	7 (54%)*,†	0 (0%)	0 (0%)	1 (8%)
Dynamic balance						
Tandem walk	5 (38%)	7 (54%)	10 (77%)	4 (31%)	7 (54%)	7 (54%)

*Significant difference within group compared to baseline, $P < 0.05$.
†Significant difference between groups, $P < 0.05$.

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vertigo in both groups showed statistically significant within-group improvement in terms of visual analogue score at the two-week and four-week assessments (Table 2). No significant difference was found between groups.

Discussion

This is a randomized controlled clinical trial to examine the effectiveness of additional vestibular stimulated exercise training on balance performance for patients with benign paroxysmal positional vertigo involving unilateral posterior semicircular canal after canalith repositioning manoeuvre. We found that additional exercise training for patients with benign paroxysmal positional vertigo increased patients' static and dynamic balance performance and enhanced functional gait ability.

Patients with benign paroxysmal positional vertigo receiving canalith repositioning manoeuvre and vestibular stimulated exercise training demonstrated statistically significant within-group improvement for stance on foam surface with eyes closed, and for single-leg stance with eyes open and eyes closed tests. This significant effect may be due to the successful repositioning of the debris during the canalith repositioning manoeuvre and/or recovery of vestibular function after vestibular stimulated exercise training. Spontaneous recovery of benign paroxysmal positional vertigo may also have possibly contributed to the improvement. Previously, Horak *et al.*[23] has reported on the effects of vestibular rehabilitation on balance in patients with chronic vestibular disorders and this was expressed as lower postural sway in conditions with altering visual and proprioceptive inputs as well as during single leg standing with eyes open and eyes closed. Our findings further support the effectiveness of the treatment on balance.

Compared with the control group, patients with benign paroxysmal positional vertigo in the experimental group demonstrated significantly less sway velocity in stance on foam surface with eyes closed and single-leg stance with eyes closed after four weeks of treatment (Table 2). In addition, more patients in the experimental group showed a sway velocity within the normal range than those in control group as shown in Table 3. There are two possibilities to explain the statistically significant between-group differences. First, the additional exercise training in the present study was specially designed to stimulate vestibular function. Before treatment, patients with benign paroxysmal positional vertigo had difficulty in maintaining an upright posture when deprived of visual and changing proprioceptive inputs. In this study, we introduced exercises involving closed eyes and with uneven support surface conditions. Under these conditions, patients with benign paroxysmal positional vertigo learned to rely heavily on their vestibular system for balance.[24] Exercises to stimulate the vestibular system by the motions of body rolling and head turning were also emphasized. Second, it should be noted that the intensity and duration of treatment were greater in the experimental group. Patients in the experimental group received an average of a total of 6.62 hours (ranging 5.33–8.00 hours) of treatment over four weeks compared with 0.31 hours over two weeks for the control group.

In tandem walk test, no significant difference for sway velocity was found between the two groups. One possible explanation may be that the tandem walk was tested with eyes open. In the static balance tests with eyes open, patients in the experimental group did not show significantly more improvement than patients in the control group either. Under this condition, patients seem to be able to use visual inputs to detect postural changes and compensate accordingly. Therefore, further dynamic balance tests are needed to further document the treatment effect of vestibular stimulated exercise training on dynamic balance.

Patients with benign paroxysmal positional vertigo in the experimental group demonstrated significantly greater scores for the Dynamic Gait Index (from 19.2 to 23.5) than members of the control group at the four-week assessment. Before treatment, our patients showed postural imbalance in the tasks of Dynamic Gait Index such as changing gait speed, gait with horizontal head turns, gait with vertical head turns, and pivot turning. Patients in the experimental group received an exercise training that emphasized on functional activities under stimulating vestibular function.

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This is probably why they demonstrated greater improvement for their functional gait performance. This improvement after additional vestibular stimulated exercise training is also consistent with a study by Dannenbaum and colleagues.[25] In their study, patients with vestibular deficits showed a significant increase of 4.2 (from 18.4 to 22.6) in their Dynamic Gait Index score.

According to the findings of Shumway-Cook *et al.*, a score of 19 or less indicates a high risk of fall in community-dwelling older adults.[9] At baseline, the percentage of patients with Dynamic Gait Index scores less than 19 was 38% for the experimental group and 22% for the control group. After treatment, the Dynamic Gait Index scores were greater than 19 for all patients in both groups. In addition, an average change of four points on Dynamic Gait Index score in patients with bilateral vestibular hypofunction has been shown to indicate a clinically significant improvement in gait function.[26] Among the patients with benign paroxysmal positional vertigo in the experimental group, 69% showed an improvement of at least four points in contrast to only 22% of patients in the control group. Therefore, additional vestibular stimulated exercise training would seem to result in an improvement in balance and in a condition at little risk for falls.

All patients with benign paroxysmal positional vertigo demonstrated an improvement in the intensity of their vertigo. However, patients that received additional vestibular stimulated exercise training did not show less vertigo than those treated with canalith repositioning manoeuvre only. In our study, except for one subject in the control group and two subjects in the experimental group, 88.5% (23/26) of all patients receiving canalith repositioning manoeuvre showed negative Dix–Hallpike responses, which is similar to the cure rate (64–88.9%) reported in the previous studies.[17,27,28] Additional vestibular stimulated exercise training does not seem to improve positional vertigo in the present study.

The main limitation of this study is small sample size, which implies that caution should be exercised when interpreting the results. Another limitation is the lack of a control intervention to rule out spontaneous recovery. Furthermore, our results only measure the short-term treatment effects of an additional four weeks of vestibular stimulated exercise training. Long-term follow-up studies will be needed to determine the long-term effects of exercise training.

In summary, vestibular stimulated exercise training for patients with benign paroxysmal positional vertigo demonstrated additional benefits in terms of balance ability and functional gait performance. Such exercise training, which emphasizes exercises using repeated stimuli to the vestibular system and exercises under altered visual and proprioceptive conditions, is recommended.

Clinical messages

- Vestibular stimulated training is beneficial in balance and functional gait ability in patients with benign paroxysmal positional vertigo after canalith repositioning manoeuvre.
- The improvement in static standing balance is noted as early as after receiving two weeks of vestibular stimulation exercise in patients with benign paroxysmal positional vertigo.

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