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Effects of Vestibular Rehabilitation Interventions in the Elderly with Chronic Unilateral Vestibular Hypofunction

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Abstract

Introduction:

Although vestibular rehabilitation therapy (VRT) methods are relatively popular in treating patients with body balance deficits of vestibular origin, only limited studies have been conducted into customized exercises for unilateral vestibular hypofunction (UVH). Furthermore, very little evidence is available on the outcomes of VRT in the elderly population with chronic UVH.

Materials and Methods:

A total of 21 patients, aged 61 to 74 years, with UVH participated in this study. The dizziness handicap inventory (DHI) was performed immediately before, and 2 and 8 weeks after treatment.

Results:

All patients showed a reduction in DHI scores during the study. The average decrease in DHI score was 25.98 points after 2 weeks' intervention ($P<0.001$) and 32.54 points at the end of the study. This improvement was observed in all DHI subscores, and was most profound in the functional aspect. The correlation between the degree of final recovery and canal paresis was not significant ($P>0.05$). There were no relationships between the scores and gender.

Conclusion:

Our study demonstrates that VRT is an effective method for the management of elderly patients with UVH, and shows maximal effect on functional aspects.

Keywords:

Vestibular, Rehabilitation, Elderly.

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Introduction

Dizziness is a common complaint among the elderly. The prevalence of vestibular disorder increases with age, affecting around 70% of individuals attending geriatric outpatient settings (1-3). Dizziness in the elderly is considered to originate from physiological alterations in the peripheral and central structures of the vestibular system. The aging process gradually compromises vestibular end organ receptors, leading to a significant reduction in vestibular nerve conduction velocity (3–6). These changes manifest as disequilibrium, falls, anxiety and loss of confidence (7,8).

Unilateral vestibular hypofunction (UVH) is a disorder that creates a reduced total or partial reduction in vestibular function on one side of the body (9). Patients with UVH frequently report symptoms such as dizziness, oscillopsia, postural instability, and gait disorders (9–12). These impairments produce significant limitations in activity and participation in the affected patient (10,13).

Surgical or pharmacologic procedures offer only limited improvement in cases of chronic vestibular dysfunction. Therefore, vestibular rehabilitation therapy (VRT) has attracted increased interest in the management of patients experiencing chronic UVH (14–16). VRT exercises are designed to facilitate central nervous system plasticity by generating substitution, habituation, and adaptation mechanisms to enhance postural stability in disorders which lead to conflicting sensory information (17,18). It has been demonstrated that VRT methods have a positive effect in improving gait and quality of life, and in reducing the symptoms of dizziness, depression, and anxiety (19–21).

Although VRT is relatively popular, only limited studies have been utilized investigating customized exercises for unilateral vestibular dysfunction. Furthermore, very little evidence is available on the outcomes of VRT in elderly patients with UVH. The objective of the current study was to assess the effect of VRT on chronic UVH in the elderly population.

Materials and Methods

I. Participants

This study was initiated after approval of the institutional ethics committee for human subject research. All subjects had verified vertigo and were reviewed by a panel of consultant specialists including a neurologist, otologist, and audiologist. As a result, 21 patients (61 to 74 years of age) diagnosed by our team with chronic decompensated unilateral vestibular deficit participated in the study. Patients with visual, cervical, or neurologic involvement were excluded. Those with fluctuating vertigo, a symptom duration of <2 months, and a history of rehabilitation in the last 4 months were also excluded.

II. Examinations

All subjects underwent full neurotologic assessments, including spontaneous nystagmus, saccades, gaze, tracking, and balance function tests. Unilateral vestibular dysfunction was confirmed by both sideway stepping test (SST) and caloric assessments. Both tests were conducted by blinded examiners.

- **SST test:** Subjects were asked to stand with their feet together and their hands by their sides, and were asked to close their eyes. The SST was considered positive if there was any lean to one side or, in some cases, forward or backward (22).
- **Caloric assessment:** Subjects were evaluated with an air caloric test at 50°C and 24°C (ICS Chartr 200, GN Otometrics, Denmark). UVH was diagnosed according to the criterion of >25% difference in slow-phase velocity between the two ears (23,24).

III. Treatment program

According to the case history, physical evaluation, and vestibular tests for each patient, an exercise plan was developed. During the physical examination, the musculoskeletal system (e.g., coordination and proprioception), and oculomotor functions (e.g., tracking, saccadic eye movements, and head thrust) were evaluated. This study was a single-blinded controlled trial, and all assessments were recorded by the same blinded examiner. The treatment protocol consisted of a combination of vestibular adaptation and habituation exercises.

- **Adaptation exercises:**

To improve gain of the vestibular responses to head movements (25,26), patients were asked to stabilize their gaze onto a target during rapid head motions, while maintaining

the target in focus (F1 point). On progression to F2 point, the target point and the patient's head rotated in equal and opposite yaw directions.

- **Habituationexercises:**

These exercises were carried out to reduce symptoms and pathological responses produced by repetitive exposure to the provoking stimulus (27). Habituation exercises were performed based on the Brandt and Daroff method (28,29).

The therapy was performed by two experienced audiologists and consisted of an 8-week course of rehabilitation sessions. Each session included a series of 25- to 40- minute exercises, four times a week. The Persian version of the dizziness handicap inventory (DHI) was used to measure the self-perceived handicapping effects of dizziness/ vertigo (30). The inventory contains 25 items that evaluate a respondent's performance along physical, emotional, and functional dimensions (31). Each item provides a choice of three responses: no (zero point), sometimes (two points), or yes (four points). The total score ranges from 0 to 100, where higher scores imply greater level of disability. Scores of 0-231,31-60,and61-100 represent mild,moderate ,and severe dizziness, respectively (32).

IV.Statistical analysis

SPSSv.18 was utilized for statistical analysis. The Wilcoxon signed rank sum test was used to compare DHI scores obtained before and after intervention. Pre-VRT and post-VRT differences between genders were analyzed using the Kruskal–Wallis test. The statistical significance level was established at P<0.05.

Results

Twenty-one patients (11 males and 10 females, mean age 67.71±5.43 years) participated in this study. Oculomotor function tests (gaze, saccades, and smooth pursuit) were within normal limits in all patients. All subjects showed a reduction in DHI scores. At the initial visit, 71% (15/21) of patients experienced moderate or severe impairment (Table 1). However, at the end of the intervention, this value decreased to 23% (P<0.001).

The mean component and total DHI scores are given in Table 2. The average decrease in DHI score was 25.98 points after 2 weeks of intervention (P<0.001), and 32.54 points at the end of the entire intervention. For all DHI components (emotional, functional, and physical), these differences were found to be statistically significant (P<0.05). The difference was most noticeable in terms of the functional aspect.

No statistical difference was found between gender and total DHI improvement score (P>0.05). The relationship between the degree of final recovery (total DHI score) and canal paresis was not meaningful (P>0.05).

Table 1: Comparison of severity of disability (DHI) before and after the exercise program

Severity of Disability	Before intervention	After intervention	p-value
Mild	3	16	P<0.001
Moderate	8	3	
Severe	10	2	

Table 2: Comparison of the average of DHI score during different stage of the study

Ear	Before intervention		2 weeks intervention		8 weeks intervention		p-value
	Mean	SD	Mean	SD	Mean	SD	
DHI-physical	15.14	7.43	8.34	9.11	6.03	4.79	P<0.001
DHI-emotional	13.52	6.68	4.85	5.67	3.56	2.44	P=0.008
DHI-functional	20.77	11.67	10.71	8.49	6.75	5.81	P<0.001
DHI-total	51.07	21.22	23.90	16.57	16.34	12.49	P<0.001

Discussion

The current investigation indicates that customized VRT exercises decrease symptoms and improve dizziness-related disability in the elderly population. While the majority of patients showed high levels of disability at the beginning of the study, most improved to a mild level of impairment by the end of the intervention.

This study shows that after an exercise program lasting 2 weeks, a rapid recovery was achieved. We also found a remarkable difference in total DHI scores between the second week and the end of the treatment program. However, this

improvement was most evident after the first 2 weeks of exercises, suggesting that the rehabilitation programs had their maximum influence during the first 2 weeks.

Our findings demonstrate that participants reported lower scores on the emotional component, with more than half of the subjects reporting mild emotional difficulty. In contrast, physical and functional problems were more often moderate or severe. These results are in accordance with findings reported by Voorde et al. and Vereeck et al. Further, Lin et al. found that a functional complaint was most prevalent aspect of dizziness-induced disability (33-35), and also reported that the emotional impairment constituted the least affected aspect.

The aging process gradually causes anatomical and neurophysiological changes within the vestibular system, resulting in vertigo and dizziness. It has been shown that the vestibular sensory epithelia undergo alterations in subjects over the age of 70 years (36,37). These structural changes would be expected to result in diminished balance performance and greater problems in recovering from a vestibular deficit. When the peripheral vestibular system is damaged unilaterally, neuronal activity reaching the ipsilateral vestibular nuclei is diminished compared with that arriving on the contralateral side. Thus, the brain interprets the asymmetry between resting firing rates as a head rotation toward the contralateral ear. This may result in disorientation, oscillopsia, or postural instability (38–40).

A reduction in the severity of dizziness-induced handicap with VRT provides patients with independence in activities of daily living and improves their quality of life. However, the improvement in disability among our participants was not similar, suggesting that disability in the elderly population is a complex phenomenon and may be explained by differences in attitudes to dizziness and coping strategies (41–43).

Unlike Bamiou et al. (44), who reported that dizziness disability is higher in subjects with severe unilateral deficit than in those with a milder condition, we did not observe any association between final recovery and degree of vestibular weakness.

Conclusion

The results of the current study suggest that vestibular rehabilitation has a positive influence on symptoms in the elderly with chronic UVH. Such exercises lead to an improvement in balance and postural stability, and a decrement in self-reported measure of handicap.

References

1. Jönsson R, Sixt E, Landahl S, Rosenhall U. Prevalence of dizziness and vertigo in an urban elderly population. J Vestib Res 2004; 14(1): 47–52.

2. Agrawal Y, Ward BK, Minor LB. Vestibular dysfunction: prevalence, impact and need for targeted treatment. J Vestib Res 2013; 23(3): 113–17.

3. Chau AT, Menant JC, Hübner PP, Lord SR, Migliaccio AA. Prevalence of vestibular disorder in older people who experience dizziness. Front Neurol 2015 ;6: 268.

4. Gazzola JM, Ganança FF, Perracini MR, Aratani MC, Dorigueto RS, Gomes CMC. O envelhecimento e o sistema vestibular. Fisioter Mov 2005;18(5): 39-48.

5. Fernández L, Breinbauer HA, Delano PH. Vertigo and dizziness in the elderly. Frontiers Neurol 2015; 26(6): 144.

6. Velázquez-Villaseñor L, Merchant SN, Tsuji K, Glynn RJ, Wall C 3rd, Rauch SD. Temporal bone studies of the human peripheral vestibular system: normative vestibular hair cell data. Ann Otol Rhinol Laryngol Suppl. 2000; 181: 14-19.

7. Barin K, Dodson EE. Dizziness in the elderly. Otolaryngol Clin North Am 2011; 44: 437-54.

8. Agrawal Y, Carey JP, Della Santina CC, Schubert MC, Minor LB. Disorders of balance and vestibular function in US adults: data from the national health and nutrition examination survey 2001-2004. Arch Intern Med 2009; 169: 938–44.

9. Gabilan YP, Perracini MR, Munhoz MS, Gananc FF. Aquatic physiotherapy for vestibular rehabilitation in patients with unilateral vestibular hypofunction: exploratory prospective study. J Vestib Res 2008; 18: 139-46.

10. Brodovsky JR, Vnenchak MJ. Vestibular rehabilitation for unilateral peripheral vestibular dysfunction. Physical Ther 2013; 93: 293-96.

11. Yardley L, Donovan-Hall M, Smith HE, Walsh BM, Mullee M, Bronstein AM. Effectiveness of primary care-based vestibular rehabilitation for chronic dizziness. Ann Intern Med 2004; 141: 598–605.

12. McDonnell M, Hillier SL. Vestibular rehabilitation for unilateral peripheral vestibular

dysfunction. Cochrane Database Syst Rev 2015;1: CD005397.
13. Arthur JC, Kortte KB, Shelhamer M, Schubert MC. Linear path integration deficits in patients with abnormal vestibular afference. Seeing Perceiving 2012; 25: 155–78.
14. Han BI, Song HS, Kim JS. Vestibular rehabilitation therapy: review of indications, mechanisms, and key exercises. J Clin Neurol 2011; 7:184–96.
15. Martins E Silva DC, Bastos VH, de Oliveira Sanchez M, Nunes MK, Orsini M, Ribeiro P, et al. Effects of vestibular rehabilitation in the elderly: a systematic review. Aging Clin Exp Res 2016;28:599–606.
16. Ricci NA, Aratani MC, Doná F, Macedo C, Caovilla HH, Ganança FF. A systematic review about the effects of the vestibular rehabilitation in middle-age and older adults. Rev Bras Fisioter 2010;14(5):361–71.
17. Rossi-Izquierdo M, Santos-Perez S, Soto-Varela A. What is the most effective vestibular rehabilitation technique in patients with unilateral peripheral vestibular disorders? Eur Arch Otorhinolaryngol 2011; 268: 1569–74.
18. Bayat A, Pourbakht A, Saki N, Zainun Z, Nikakhlagh S, Mirmomeni G. Vestibular rehabilitation outcomes in the elderly with chronic vestibular dysfunction. Iran Red Crescent Med J 2012; 14(11): 705–8.
19. Ricci NA, Aratani MC, Doná F, Macedo C, Caovilla HH, Ganança FF. A systematic review about the effects of the vestibular rehabilitation in middle-age and older adults. Rev Bras Fisioter 2010; 14(5): 361–71.
20. Cohen HS, Kimball KT. Increased independence and decreased vertigo after vestibular rehabilitation. Otolaryngol Head Neck Surg 2003; 128:60–70.
21. McDonnell M, Hillier SL. Vestibular rehabilitation for unilateral peripheral vestibular dysfunction. Cochrane Database Syst Rev 2011; Feb 16;(2):CD005397.
22. Al Saif AA, Alsenany S. The Efficiency of the sideways stepping test in detecting unilateral vestibular hypofunction. J Phys Ther Sci 2014; 26:1719–22.
23. Gandolfi MM, Reilly EK, Galatioto J, Judson RB, Kim AH. Cost-effective analysis of unilateral vestibular weakness investigation. Otol Neurotol 2015; 36(2):277–281.
24. Voelker CC, Lucisano A, Kallogjeri D, Sinks BC, Goebel JA. Comparison of the gaze stabilization test and the dynamic visual acuity test in unilateral vestibular loss patients and controls. Otol Neurotol 2015;36(4):746–53.
25. Brodovsky JR1, Vnenchak MJ. Vestibular rehabilitation for unilateral peripheral vestibular dysfunction. Phys Ther 2013; 93(3):293–98.
26. Hall CD, Herdman SJ, Whitney SL, Cass SP, Clendaniel RA, Fife TD. Vestibular rehabilitation for peripheral vestibular hypofunction: an evidence-based clinical practice guideline. J Neurol Phys Ther 2016;40(2):124–55.
27. Clendaniel RA. The effects of habituation and gaze-stability exercises in the treatment of unilateral vestibular hypofunction – preliminary results. J Neurol Phys Ther 2010;34(2):111–16.
28. Brandt T, Steddin S, Daroff RB. Therapy for benign paroxysmal positioning vertigo, revisited. Neurology 1994;44(5):796–800.
29. Whitney SL, Marchetti GF. Management of the elderly person with vestibular hypofunction. In: Herdman SJ (editor). Vestibular rehabilitation. 4th ed. Philadelphia: F.A. Davis Company; 2007: 376-90.
30. Jafarzadeh S, Bahrami E, Pourbakht A, Jalaie S, Daneshi A. Validity and reliability of the Persian version of the dizziness handicap inventory. J Res Med Sci 2014;19(8):769–75.
31. Jacobson G, Newman C. The development of the Dizziness Handicap Inventory. Arch Otolaryngol Head Neck Surg 1990;116:424–27.
32. Whitney SL, Wrisley DM, Brown KE, Furman JM. Is perception of handicap related to functional performance in persons with vestibular dysfunction? Otol Neurotol 2004;25(2): 139–43.
33. Ten Voorde M, van der Zaag-Loonen HJ, van Leeuwen RB. Dizziness impairs health related quality of life. Qual Life Res 2012;21(6):961–66.
34. Vereeck L, Truijen S, Wuyts FL, Van de Heyning, PH. The dizziness handicap inventory and its relationshipwith functional balance performance. Otol Neurotol 2007;28(1):87–93.
35. Lin SI, Tsai TT, Lee IH, Wu YN. Perception of unsteadiness in patients with dizziness: association with handicap and imbalance. J Biomed Sci 2002; 9(5):428–35
36. Sloane PD, Baloh RW, Honrubia V. The vestibular system in the elderly: clinical implications. Am J Otolaryngol 1989; 10(6): 422–29.
37. Chau AT, Menant JC, Hübner PP, Lord SR, Migliaccio AA. Prevalence of vestibular disorder in older people who experience dizziness. Front Neurol 2015; 6: 268–78.
38. Fetter M, Dichgans J. Adaptive mechanisms of VOR compensation after unilateral peripheral vestibular lesions in humans. J Vestib Res 1990; 1: 9–22.
39. Schubert MC, Minor LB. Vestibulo-ocular physiology underlying vestibular hypofunction. Phys Ther 2004; 84(4): 373–85.
40. Hillier S, McDonnell M. Is vestibular rehabilitation effective in improving dizziness and function after unilateral peripheral vestibular

hypofunction? an abridged version of a Cochrane review. Eur J Phys Rehabil Med 2016; 52 (4): 541-56.
41. Telian SA, Shepard NT, Smith-Wheelock M, Kemink JL. Habituation therapy for chronic vestibular dysfunction: preliminary results. Otolaryngol Head Neck Surg 1990;103(1):89–96.
42. Clendaniel RA. The effects of habituation and gaze-stability exercises in the treatment of unilateral vestibular hypofunction – preliminary results. J Neurol Phys Ther 2010; 34(2): 111–16.
43. Hallam RS, Stephens SD. Vestibular disorder and emotional distress. J Psychosom Res 1985; 29(4):407–13.
44. Bamiou DE, Davies RA, McKee M, Luxon LM. The effect of severity of unilateral vestibular dysfunction on symptoms, disabilities and handicap in vertiginous patients. Clin Otolaryngol Allied Sci 1999; 24(1):31–38.