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Research Article

Virtual Reality (VR) for Vestibular Rehabilitation: A Pilot Study Comparing VR with Conventional Rehabilitation with Conventional Rehabilitation Alone

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Abstract

Introduction: The current pilot study aims to establish the feasibility and benefit of adding Virtual reality based training to conventional vestibular therapy for rehabilitation of patients with vestibular disorders.

Materials and Methods: Patients with chronic vestibular problems, undergoing Vestibular Rehabilitation Therapy (VRT), were divided into two groups of 5 patients each. Group B received conventional vestibular therapy alone, Group A had a Head mounted Virtual Reality therapy in addition to conventional VRT. The Dizziness handicap Inventory was administered to the patients before, during and after the treatment course to objectively assess benefits.

Results: Group A with VRT and Vestibular Rehabilitation had demonstrably better response to therapy than the group B with Vestibular Rehabilitation alone. No patient complained of discomfort during the VR therapy.

Conclusions: Though the numbers were small and the results not statistically analysable, this pilot study suggests that addition of VRT to vestibular rehabilitation protocols has benefit.

Keywords: Virtual Reality (VR); Vestibular Rehabilitation Therapy (VRT); Conventional Rehabilitation

Introduction

Vestibular Rehabilitation Therapy (VRT) began with Cawthorne-Cooksey exercises given to patients with labyrinth deficiency after head trauma. The main principle of VRT is to promote a natural vestibular recovery process, generally attributed to the vestibular compensation phenomenon. This is achieved by adaptation, habituation and substitution mechanisms, Correction of unbalanced vestibular, proprioceptive and visual inputs is obtained by auditory and visual feedback or optokinetic training combined with physical exercise involving upper body, head and eye movement [1]. VRT is a non-invasive, safe and effective treatment in patients with acute or chronic peripheral vestibular loss. Patients with peripheral lesions but poor spontaneous vestibular compensation respond well to this form of therapy. Conventional VRT exercises must be performed several times, amounting to 20 - 40 minutes of exercise per day, which some patients find repetitive and monotonous. Furthermore, it is difficult for patients to receive feedback while training at home [2].

Virtual Reality (VR) is a widely applied technique for generating a virtual environment, interactive simulations of the real world using various forms of display - spherical, flat screen or head-mounted. The user can interact with objects in VR using his body movement, and hardware devices can be added to the equipment in order to monitor motion kinematics or provide simulations of force or Haptic feedback to participants. VR has recently gained popularity in medicine with the rapid development of mobile and visual technologies.

Given that motor skills can be learned in a virtual environment and later on applied into the real world and that virtual settings can provide controlled and/or augmented feedback on motor performance, it is not surprising that medical rehabilitation began to use heavily such settings as therapeutic tools. It has been successfully applied in various medical specialties, for example: psychiatry in treating anxiety, schizophrenia and cognitive impairments; post-stroke hemiplegia; or in pediatrics, in the rehabilitation of cerebral palsy.

VR was introduced to vestibular rehabilitation with various devices and protocols in which VR techniques had a similar effect to conventional vestibular therapy. The motivational and enjoyment aspect of virtual reality-based programs may result in better compliance with exercises than conventional therapy. With lowering of costs, this method may become more affordable for rehabilitation centers than certified static posturography, and it may be possible to introduce it as home therapy for maintaining vestibular compensation [3].

We developed a Virtual reality based head mounted goggle with unique games, which mimic real life situations, and undertook a pilot study on its effectiveness in vestibular rehabilitation, in comparison with conventional vestibular rehabilitation exercises.

Aims and Objectives

- To establish efficacy of Virtual reality based Vestibular Rehabilitation in patients with difficulty in compensation after vestibulopathies of various causes.
- To compare benefit of VR based Rehabilitation combined with conventional Rehabilitation over Physical Rehabilitation alone.
- To establish safety and document patient problems with the use of the VR device.

Material and Methods

The study was carried out in the CYCLOPS Vertigo Clinic, Bangalore, a referral clinic for patients with vertigo for diagnosis treatment and rehabilitation, during the time period from January 2019 to June 2019.

Patients attending the clinic, who had completed treatment for their primary vestibular disorder, who were assigned for vestibular rehabilitation to aid in compensating for vestibular handicap, were selected for this study. They were explained the pilot nature of the study and were assured that in case of any discomfort the Virtual Reality programme would be discontinued and the conventional treatment would be continued.

An Institute Ethical Board permission was sought and obtained, prior to commencement of the study.

The patients were sequentially assigned to the two arms. The first 5 patients Group A were patients who received Physical Therapy with VRT and Group B patients were subjected to Physical Therapy alone.

The equipment used was a VR Gaming Device, with a head mounted display and customized software developed by Cyclops Medtech Pvt ltd, which had a variety of games, ranging from Walking the plank to test ability to negotiate heights, to a water boat ride, a supermarket environment simulation, an elevator ride, to a simulation of a Barany drum.

The Rehabilitation programme for the VRT used gaze stabilization, standing balance and walking exercises individually tailored to each subject. Each patient completed 12 sessions each one week apart.

Assessment of benefits used the standard DHI scales. Taken at 0 weeks (pretreatment), 6 weeks (interim), and 12 weeks (post-treatment) and a questionnaire was administered to establish intra test problems.

Results

There were 7 males and 3 females in the study groups, and their age ranged from 25 to 60 yrs Mean age 48.8 yrs in the VRT group, and 48.2 yrs in the Conventional Therapy group.

The diagnosis were diverse ranging from Menieres to cerebellar degeneration, migranous vertigo, etc. These patients had a minimum of two months time elapsed after the onset of the initial symptoms (Table 1A and 1B).

Serial No	Sex	Age	Diagnosis
1	M	60	Right Labyrinthitis
2	F	32	Migranous Vertigo
3	M	25	Right vestibular neurectomy
4	M	65	Cervical vertigo
5	M	62	Visual vertigo

Table 1A: Virtual reality with conventional vestibular rehabilitation group.

Serial No	Sex	Age	Diagnosis
6	M	50	Right Meniere
7	M	65	Cerebellar Degeneration
8	F	28	Migranous vertigo
9	M	40	Motion sickness
10	F	58	Post BPPV

Table 1B: Conventional vestibular rehabilitation group.

Dizziness Handicap Inventory (DHI) scores as obtained by interviewing the patients were tabulated, and these show a distinct tendency to decrease with rehabilitation.

Given the limited sample size no attempt to obtain statistical significance were made. However, the trend towards improvement in both groups, both A and B is evident, showing that some form of therapy is beneficial.

However the improvement when the patients took Virtual Rehabilitation as part of the exercise Group A is evident, and scores ranging from 14 to 24 with a mean of 20, are remarkably better that those without VR Group B wherein scores ranging from 28 to 50 with a mean of 42 were obtained (Table 2A and 2B).

Sr No	Diagnosis	DHI pre treatment	DHI interim	DHI Post treatment
1	Right Labyrinthitis	66	54	20
2	Migranous Vertigo	64	50	14
3	Right vestibular neurectomy	76	50	18
4	Cervical vertigo	68	46	24
5	Visual vertigo	78	58	24
	Mean	70.4	51.6	20
	Standard deviation	6.22896	4.560702	4.242641

Table 2A: Group A; DHI scores.

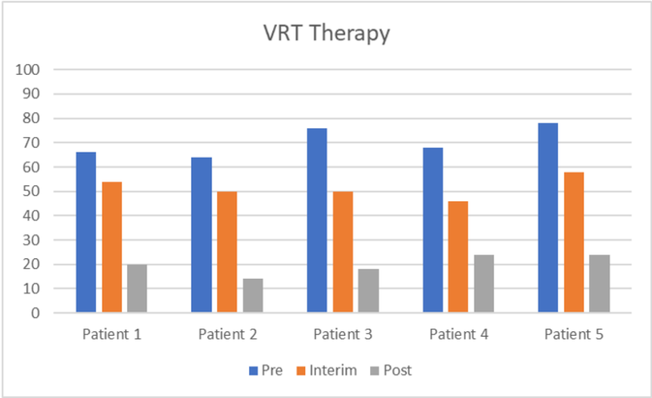
Sr No	Diagnosis	DHI pre treatment	DHI interim	DHI Post treatment
1	Right Meniere	72	56	50
2	Cerebellar Degeneration	74	68	66
3	Migranous vertigo	64	52	28
4	Motion sickness	48	42	38
5	Post BPPV	62	54	46
	Mean	64	54.4	45.6
	Standard deviation	10.29563	9.316652	14.17039

Table 2B: Group B, DHI scores.

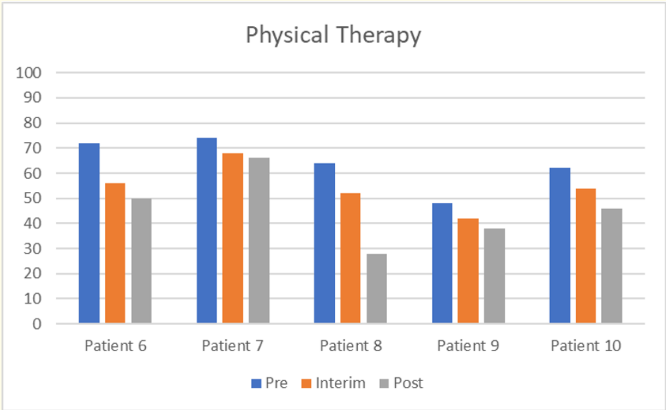
This is further demonstrated graphically over graph 1 to 3.

	VRT (Pre)	PT (Pre)	VRT (Interim)	PT (Interim)	VRT 1 (Post)	PT (Post)
DHI Scores	66	72	54	56	20	50
	64	74	50	68	14	66
	76	64	50	52	18	28
	68	48	46	42	24	38
	78	62	58	54	24	46

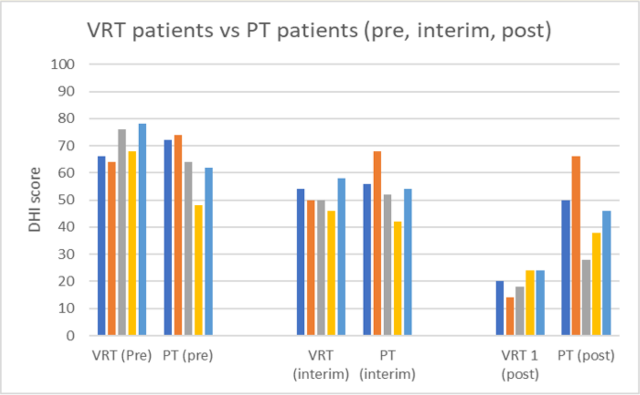
Table 3: Comparison of DHI scores across both groups - VRT vs PT patients.



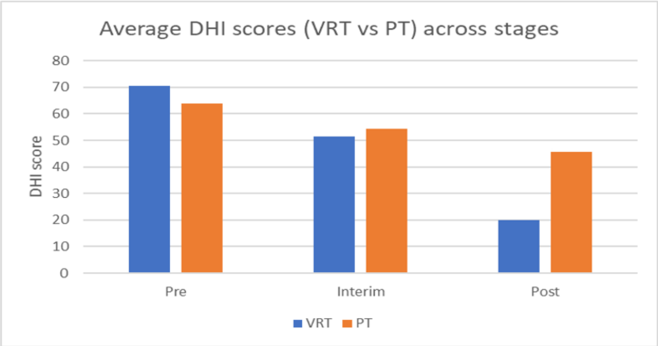
Graph 1A: Showing decrease in DHI during the course of the treatment in group A.



Graph 1B: Showing decrease in DHI during the course of the treatment in group B.



Graph 2



Graph 3

Discussion

In the presented study, none of the randomized patients had achieved spontaneous recovery by two months. The two-month criterion was introduced to exclude patients with acute symptoms and to provide sufficient time for spontaneous compensation prior to commencement of therapy.

Though studies on peripheral vestibular deficiency conclude that significant improvement in vestibular rehabilitation in patients with poor spontaneous compensation is possible six months from the onset of symptoms, the purpose of establishing benefit would not be served by delaying to that extent.

The classical therapeutic approach for vestibular disorders relies on vestibular rehabilitation and symptomatic medication. Vestibular rehabilitation uses central mechanisms of neuroplasticity (adaptation, habituation, and substitution) to increase static and dynamic postural stability and to improve visuovestibular interactions in situations that generate conflicting sensory information. Vestibular rehabilitation can improve static and dynamic balance and gait, reduce symptoms of dizziness of comorbid depression and of anxiety, and ultimately result in an increase of self confidence and quality of life of sufferers.

Vestibular rehabilitation has been proposed to improve the quality of life of individuals experiencing dizzy spells and body imbalance. It is based in a program of exercises for the eyes, head, and body, involving specific physical maneuvers associated with changes of life stylee clarification on imbalance. Vestibular rehabilitation is a physiological, innocuous, coherent therapy that acts on the vestibular system to stimulate central nervous system plasticity, promote the reinstatement of body balance, accelerate and stimulate the natural mechanisms of compensation, adaptation and acclimatization [4].

However, many factors may negatively affect the outcome of vestibular rehabilitation, including incorrect performance of exercises and the necessity of active efforts and interest from the patient. Due to the variability of patients' response to therapy, more efficient and cost-effective therapeutic tools are definitely needed for vestibular rehabilitation.

Virtual reality-based treatment has a definite role in rehabilitation of vestibular disordered patient [5]. The use of Virtual Reality exercises aim to modify the subject's postural control system by exposing the patient to different visual environments along with congruent and conflicting stimuli; mitigate dizziness and body imbalance; enhance the stability of the patient's gaze and improve his/her postural control, competence, and well-being while performing activities of daily living.

Virtual reality enables patients to dive into a world of illusion. The perception of the environment is modified by artificial stimuli, generating sensory conflict and altering the gain of the vestibulo-ocular reflex. Repetitive movements of images on the retina produced by virtual reality devices designed to control visual stimuli may induce vestibular response adaptation and adjust the vestibulo-ocular and vestibulospinal reflexes involved in postural control and body balance strategies. Virtual reality technology enables therapists to offer patients a wide range of highly specific stimuli and sensory conflicts of varying degrees of complexity in a safe environment.

Body balance rehabilitation with virtual reality stimuli effectively improved symptoms of dizziness, quality of life, and stability limits of patients with Ménière's disease, visual vertigo, and dizziness of elderly.

In the current study, when Dizziness Handicap Inventory Scores were tabulated as a form of objective measurements, patients showed improvement in both groups, but the addition of Virtual Reality Games, resulted in a definite tendency to a faster resolution of symptoms.

Cawthorn and Cooksey, in their original studies, recommended that VRT exercises should be performed with eyes open and closed. According to their findings, performing with eyes closed decreased the patient's reliance on visual information and probably increased the vestibular and somatosensory input to the compensation mechanisms. It is possible that, because in VR conditions the visual input is modified and different than the patient's surrounding, a similar compensatory shift occurs. Such a phenomenon might contribute to benefit as a greater improvement measured in eyes-closed conditions [4].

A systemic review by Bergeron., *et al*. expressed concern that the use of virtual reality might be limited by motion- or cybersickness because of excessive sensory stimulation. This is due to unnatural and sometimes conflicting multisensory stimuli, exposure to interactive virtual environments can cause discomfort during or after the session [5].

The symptoms reported are motion sickness-like, including nausea, vomiting, headache, somnolence, loss of balance, and altered eye hand coordination. These undesirable events, which can be distinguished from classical motion sickness caused by vestibular stimulation alone, are particularly worrying in participants with impaired vestibular function. The occurrence of cybersickness should be systematically documented before virtual rehabilitation could be used on larger scales for these populations of patients. However, despite these limits, the absence of reported side effects or adverse events (e.g. falls) so far tends to support the notion that virtual rehabilitation is well tolerated and could be safely used in a rehabilitation setting.

None of the patients in the current study complained of cybersickness or an exacerbation of symptoms during rehabilitation hence we are unable to comment on the frequency of these symptoms in our setting.

Conclusion

Virtual reality-based vestibular rehabilitation in combination with the conventional physical rehabilitation is an enjoyable and well-tolerated method of training. Virtual reality training seems to have a better effect on the subjective reduction of symptoms than conventional physical rehabilitation alone.

A systematic multi centre randomized controlled trial, with larger numbers of patients of a specific diagnosis is indicated for conclusively establishing the benefits of such an approach.

Bibliography

1. Rosiak Oskar., "Evaluation of the effectiveness of a Virtual Reality-based exercise program for Unilateral Peripheral Vestibular Deficit". *Journal of Vestibular Research* 28.5-6 (2018): 409-415.
2. Pavlou M., *et al.* "The effect of virtual reality on visual vertigo symptoms in patients with peripheral vestibular dysfunction: A pilot study". *Journal of Vestibular Research* 22.5-6 (2012): 273-281.
3. Su-Yi Hsu., et al. "Dimensional, virtual reality vestibular rehabilitation for chronic imbalance problem caused by Ménière's disease: a pilot study". *Journal of Disability and Rehabilitation* 39.16 (2017): 1601-1606.
4. Adriana Pontin Garcia., *et al.* "Vestibular rehabilitation with virtual reality in Ménière's disease". *Brazilian Journal of Otorhinolaryngology* 79.3 (2013): 366-374.
5. Mathieu Bergeron., *et al.* "Use of Virtual Reality Tools for Vestibular Disorders Rehabilitation: A Comprehensive Analysis". *Advances in Medicine* (2015).