



## VIRTUAL REALITY IN VESTIBULAR REHABILITATION: A TAILORED CARE - IS THIS THE FUTURE?

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### ABSTRACT

Review of articles from the literature to essentially assess the future of vestibular rehabilitation which is mostly focussed on Virtual Reality (VR) being a major part of the rehabilitation plan. Virtual reality is also the forerunner in present day technology as it provides the real world situation based therapy for patients experiencing dizziness in certain specific situations of every day life . It also does improve the compliance rates of the therapy thus improving the results achieved .On reviewing the literature four papers were selected between 2012-18 . These revealed Virtual Reality Based Therapy (VRBT) to be more beneficial, enjoyable and compliant in treating the peripheral vestibular disorders.

#### Key words:

Virtual reality, Vestibular rehabilitation

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### INTRODUCTION

Vestibular dysfunction is the most common cause for vertigo<sup>1</sup>. Various Vestibular Rehabilitation therapies have been tried so far with variable results. However with technological advances the Virtual Reality has been in the forefront to treat peripheral vestibular disorder. Following a thorough review of literature , the following four papers between 2012 & 2018 were selected as the range of the comparative studies between the conventional vestibular therapy & Virtual Reality based therapy varied from military studies to an extensive review article looking at various virtual reality scenarios .Since the articles are from 2012 to 2018, the data and technology also varied with new research in this area.

### DISCUSSION

In our first article a sample of four patients with mild traumatic brain injury who utilised Computer Assisted Rehabilitation environment (CAREN) in place of traditional vestibular physical therapy were followed through a twice weekly regime for 6 weeks<sup>1</sup>. These individuals suffered from blunt and blast trauma. Patients has both sensory and motor issues noted on testing. CAREN involves a moving platform with integrated treadmill and force plate that is referenced to a virtual scenario .Balance assessment modules included computerized dynamic posturography /sensory organisational test , visual acuity and stable gaze test, functional gait assessment and self report questionnaires like Jacobson dizziness handicap index and activities balance scale<sup>1</sup>. This module was undertaken by

each patient at the start of the therapy, then at 3 weeks and after completing the therapy at 6 weeks<sup>1</sup>.

Vestibular physical therapy rehabilitation included VOR (vestibulo ocular reflex) exercises, cervical ocular exercises, proprioceptive neuromuscular facilitation exercises and plyometrics. This was a 12 session programmer both the traditional vestibular physical therapy and CAREN<sup>1</sup>. CAREN used four interactive applications like endless road, forest road, mountain terrain and boat slalom. In here the motion platform moved in sync to the terrain changes with the treadmill speed changes varying along the test.Post rehabilitation using CAREN there was a significant improvement in the dizziness handicap index with increased confidence scores<sup>1</sup>. Dynamic visual acuity testing, gaze stabilisation and target tracking also showed marked improvement.Fast improvements in gait was noticed with Boat Slalom application .In conclusion this form of therapy is also highly motivational in young individuals.In the virtual world with complex tasks and increased motivation, the recovery could be expedited<sup>1</sup>.

Peripheral vestibular loss being the most common causes of severe vertigo and nausea, the apprehensive nature of the possibility of the attacks results in absence of work and a cost to society. Virtual reality (VR) therapy has been furthering the technology providing two types of movement sensors which are motion trackers and force -plate platforms. Third one is a combination of the two called a "hybrid" VR unit.In this prospective ,non-randomised comparative controlled group study between hybrid VR vs static posturography with visual feedback was looked at.

Patients were diagnosed at the Balance Disorders Unit, Otolaryngology Department, Medical University of Łódź following fulfilling the study requisites which included persistent vertigo and disequilibrium with unsatisfactory spontaneous compensation a least two months post-onset and unilateral peripheral vestibulopathy confirmed by videonystagmography<sup>2</sup>. A total of fifty patients were assigned to the study groups using alternating sequence with odd and even number split. Each group of 25 patients received ten training sessions lasting 30 minutes for two weeks. Both the groups were overlooked by a physiotherapist during the therapy sessions. Both the sets aimed at focussing and maintaining the centre of pressure (COP) at predetermined or indicated positions. Post therapy patients filled in the Vertigo Syndrome Scale- Short Form (VSS-SF)<sup>2</sup>. Each patient was exposed to 300 minutes in this protocol. Patients showed statistical improvements on objective measurement testing with encouraging results in eyes-closed conditions. Hybrid VR was found in no way superior in postural sway reduction in comparison to the accepted vestibular rehabilitation. Virtual reality based vestibular rehabilitation is found to reduce the subjective symptoms considerably and is a compliant and enjoyable method of vestibular rehabilitation<sup>2</sup>.

In the next review article titled "Use of Virtual Reality Tool for Vestibular Disorders Rehabilitation : A Comprehensive Analysis" authors have systematically reviewed the current literature to analyse the published protocols for virtual reality settings in peripheral vestibular disorders rehabilitation. An important relationship between the duration of exposure to virtual reality environments and the magnitude of the therapeutic effects revealed that VR regimen should last for at least 150 minutes to achieve positive outcomes. As known the process of adaptation, habituation and substitution are the mechanisms in vestibular rehabilitation. Factors such as motivation and incorrect performances of exercises can affect the outcome of vestibular rehabilitation. Medline search with certain key words were used in selection of relevant primary studies. With inclusion criteria data extraction was done subsequently. Mainly three measures firstly percentage of improvement on DSI, secondly the percentage of improvement on another scale used by author and lastly the average efficiency compacted as the mean measured between the two scales was used. Mann-Whitney U tests were used for statistical analysis.

Seven studies with 176 subjects fulfilled the criteria. Age was between 18-84 years. Patients were subjected to 6-12 sessions spread over 1 to 8 weeks with each session lasting between 24 to 45 minutes. Devices used were either screen/projection or headset/goggles in addition to some studies having treadmill or a force platform added to enhance the rehabilitation process. Five studies used goggles and 2 used screen in front of the patient<sup>3</sup>. Interestingly the type of device did not have an effect on the efficacy. A clear improvement with VR was noticed in all these studies with a significant improvement in the scales. Side effects were not documented in any studies which is interesting. One study was randomised out of the 7 studies and 4 had a control<sup>3</sup>. Essentially the studies did clearly demonstrate the advantage and improvement noticed with the virtual reality technology utilisation in treatment of vestibular disorders. Protocol design is important and DHI should be the validated tool to be used<sup>3</sup>. Time duration of a minimum of 120-150 minutes was noted to be essential to detect a quantifiable benefit to patients. Also to note, the longer sessions

in a short interval was more beneficial. With regards to the clinical applicability, self utilisation of virtual reality devices by patients could in fact reduce the rehabilitation costs. Further, none of the studies concluded whether VR with conventional Vestibular rehabilitation or VR alone was effective to achieve good results. Cybersickness has been under reported in these studies<sup>3</sup>.

Last study is looking at the comparison of VR based therapy (VRBT) with customise vestibular physical therapy (PT) for treating the vestibular disorders. Twenty patients received VRBT and 18 received PT. A virtual grocery store environment with a treadmill was used for 6 sessions one week apart whereas the PT included gaze stabilisation, standing balance and walking exercises individually tailored to each patient. Study protocol was designed and approved by the University of Pittsburgh Institutional Review Board with 38 subjects<sup>4</sup>. Neurologic disease, use of assisted devices for ambulation, total hip or knee replacement and severe arthritis were the exclusion criteria. Following the initial 1 hour evaluation, five follow up sessions were planned with a daily exercise diary<sup>4</sup>. Two physical therapists performed the intervention. Subjective Units of Discomfort (SUD 0-100) were used to assess the improvements in VRBT protocol. The VR store protocol had 16 aisles and 8 levels depending on the spatial frequency and contrast of product textures. The front screen was 1.5m from the user<sup>4</sup>.

The Activities-specific Balance confidence scale (ABC) was used to record the patient's level of balance confidence<sup>4</sup>. DHI was used in this study. Anxiety or discomfort in real life situations was noted through Situational Characteristics Questionnaire. Dynamic Gait index was used to assess various gait activities with 8 items on the scale. Each item was scored from 0-3. Scores of 22 or less have been related to increased fall<sup>4</sup>. The optimal score was 24. With VRBT, Visual Analogue score was used. Interestingly the study did not find difference between PT and VRBT<sup>4</sup>. Suggestion was primarily VRBT is the viable option when there is space and motion discomfort.

## CONCLUSION

Virtual Reality based therapy in Vestibular Rehabilitation with a minimum treatment time interval of 120-150 minutes with 6-10 sessions in a patient controlled study designed environment with DHI assessment to evaluate improvement at the beginning and at 6 week & 6 month interval is found to have probably the best results as noted from these studies. However there needs to be more studies to achieve a standardised and cost effective protocol for treating patients with peripheral vestibular dysfunction using the virtual reality based therapy.

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