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Effect of virtual reality on eye hand coordination and depth perception in patients with vertigo-an experimental study

Dr. Jui Metha
Intern Collage of Physiotherapy, Wanless Hospital, MMC, India
juimetha@gmail.com

Dr.Vrushali Bhore
Department of Neurophysiotherapy,
College of Physiotherapy, Wanless Hospital, MMC, Miraj, India.
vrushalibhore@gmail.com

ARTICLE DETAILS

Research Paper

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ABSTRACT

Background:

Vertigo is defined as a feeling of instability. They are a prevalent and significant problem among elderly, whose prevalence rises to 30% after age 65 to 50% after age 85. In general, 8- 18% of children and 20-30% of adults experience vertigo.

Purpose:

To assess effect of virtual reality on depth perception and eye hand coordination in patients with vertigo.

Methodology:

The intervention and the study were explained to the participants. We obtained their informed written consent. The selection criteria led to the selection of 44 participants. The Graded Circle Test and the Alternate Hand Wall Toss were used as outcome measures both before and after the treatment. Five therapy sessions over the course of five days comprised the intervention program.

Result:

The results indicate that in patients with vertigo, there is a substantial difference in the before and post scores on the Graded Circle Test and Alternate Hand Wall Toss.

Conclusion:

The current investigation found that individuals with vertigo significantly improved in their ability to perceive depth and their eye-hand coordination.

I. INTRODUCTION

Vertigo is defined as a feeling of instability. They are a prevalent and significant problem among elderly, whose prevalence rises to 30% after age 65 to 50% after age 85. In general, 8-18% of children and 20-30% of adults experience vertigo and dizziness. Autonomic symptoms, which include pallor, sweating, nausea, and vomiting, are rarely seen in other forms of dizziness but are frequently linked to vertigo. Most often, it appears as though the patient's feet are rising or falling away from them when external objects rotate and move vertically. This usually cause a fall.[1]

Vertigo is typically understood to be a sensation of things whirling or shifting. However, this word is usually linked to symptoms of dizziness (Experiencing dizziness or a "swimmy"),
visual awareness and/or equilibrium in the general public. In particular, the vestibular system, which overlaps with other cerebral networks, may be the source of all these symptoms. Vertigo, unbalance, and other related symptoms could result from damage to this system, as well as more widespread cognitive or emotional issues. According to comments from clinicians, in addition to the common association between vertigo and emotional disorders, patients with vertigo often experience concurrent cognitive deficits, including attention, memory, and space perception.[2]

These conditions provide related symptoms – such as hearing loss, tinnitus, and nausea- an extra significance. One such symptom is the persistence of an aftereffect of unsteadiness that may linger for hours or even days. The capacity to carry out precise, smooth and controlled motor response is referred to as coordination or coordinated movements. It is a symptom that is frequently present and can make performing everyday tasks very difficult.[2]

Due to the multiple etiology of vestibular diseases, patients with vertigo can receive treatment through a variety of vestibular rehabilitation techniques. Locomotor rehabilitation, pharmacological therapy (both symptomatic and causative), and surgical therapy (for pathologies of the inner and/or middle ear structures, Meniere's disease, VIII nerve tumours, and cervical spine disorders) are the main components of these treatments. The latter aims to accelerate the centrally acting compensatory process by leveraging physiological mechanisms operating at the level of the central nervous system. Such forms of acceleration are now believed to be accomplished via exposure to sensory conflicts, which during habituation gradually diminish sensitivity to stimuli.[5]

Repositioning procedures are a special kind of locomotory rehabilitation that address benign paroxysmal positional vertigo (BPPV) and are predicated on the notion of mechanical disruptions to the semicircular canal complex.These consist of the Epley reposition manoeuvre, the Semont release manoeuvre, and the positioning exercises of Brandt and Daroff. When treating peripheral vestibular system impairment, habituation exercises are typically included in the rehabilitation process.[5]

The ability to see objects as three-dimensional artefacts and to estimate one’s own distance from an object is known as depth perception. While seeing the identical phenomenon, this is defined by integrating the difference that has occurred in each eye.[3]

The precise activation of the manual motor and ocular systems is required for the intricate process of eye-hand coordination (EHC). Accurate and timely movements, such reaching out and picking up small objects, need simultaneous control of the hands and eyes in addition to the acquisition of high-quality visual information about the surroundings. Hand-eye coordination is a basic motor skill that refers to the brain's ability to coordinate hand movements in response to visual stimuli.[3]

When reaching for or touching objects in our three-dimensional environment, the eyes will frequently fixate on objects of interest before the hand moves. Saccades, which are rapid eye movements that shift the attention from one part of the visual scene to another, are the cause of this fixation. This sharpens the focus on the object of interest on the fovea, the region of the retina with the highest level of visual acuity.[5]

Using computer technology to produce an animated picture or environment of things, space, and events is known as virtual reality. Additionally, this technology is being utilised more and more in the medical field, both as a component of therapy and for interactive training in stimulation centres. This virtual environment has been developed with sound, smell, touch, and visual components, allowing for interaction with the recipient. There has been an increase in the use of this technology for both education and leisure. It has been used to build construction machine simulators, civil and military aircraft simulators, and virtual stores and museums. Furthermore, this technology is finding increasing application in the medical field, where it is being used for interactive training in simulation centres as well as as part of rehabilitation. Virtual reality finds application in the fields of psychiatry, burn analgesia, post-traumatic stress disorder, Alzheimer's and Parkinson's disease, and stroke recovery. The benefits of virtual reality (VR) in treating childhood autism spectrum disorders have been more thoroughly documented by study.[5]

MATERIALS & METHODS

MATERIALS

1. Ball
2. Stop watch
3. Wall
4. Virtual reality setup
5. VR goggles

METHODOLOGY

- Study design: Experimental study
- Study type: Pre and Post Intervention
- Study duration: 6 months
- Type of sampling: Purposive sampling
- Sample size:44
- Study setting: tertiary healthcare center and community of Sangli and Miraj

PROCEDURE

Ethical committee clearance was been obtained. Permission was taken from teritary Care Center Miraj to do the screening. Following the selection of participants based on the inclusion and exclusion criteria, the protocol was explained to them in their native tongue, and their signed consent was obtained. Pre intervention assessment with graded circle test and alternate hand wall toss was done and then the intervention was started for 5 session for 5 days. After this the post interventional assessment was taken with the above-mentioned tests and the scores were compared by statistical analysis and then the results were concluded.

Statistical Analysis

Since no variable in the observation has a p-value greater than 0.05, the data set is not normally distributed. In the sections that follow, the researcher will analyse data using non-parametric tests. MS-Excel 2013 is used to create graphs, while SPSS version 23 is used for all data analysis. With paired samples, the Wilcoxon test is used for analysis inside the group.

For all tests 5% significance level was followed.

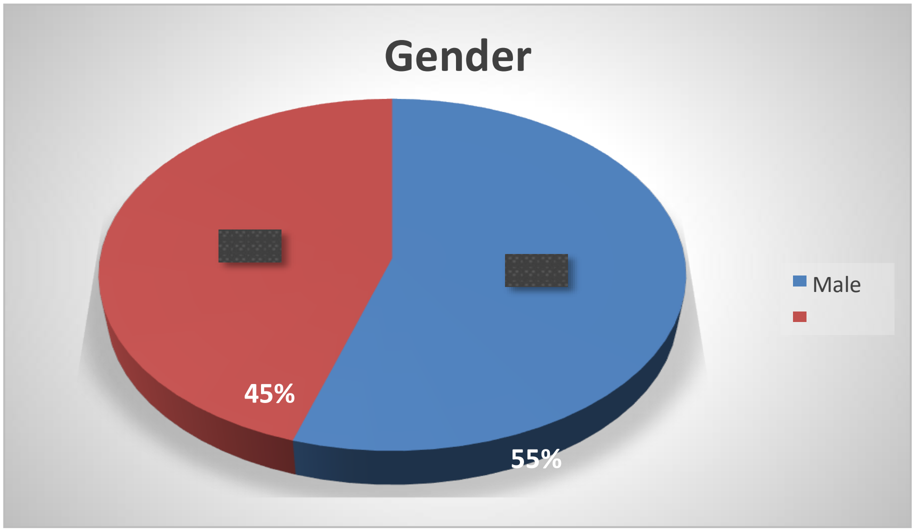
RESULT

Descriptive Statistics

Variable – Gender

Table no 1

Gender	Frequency	Percent
Male	24	55
Female	20	45
Total	44	100

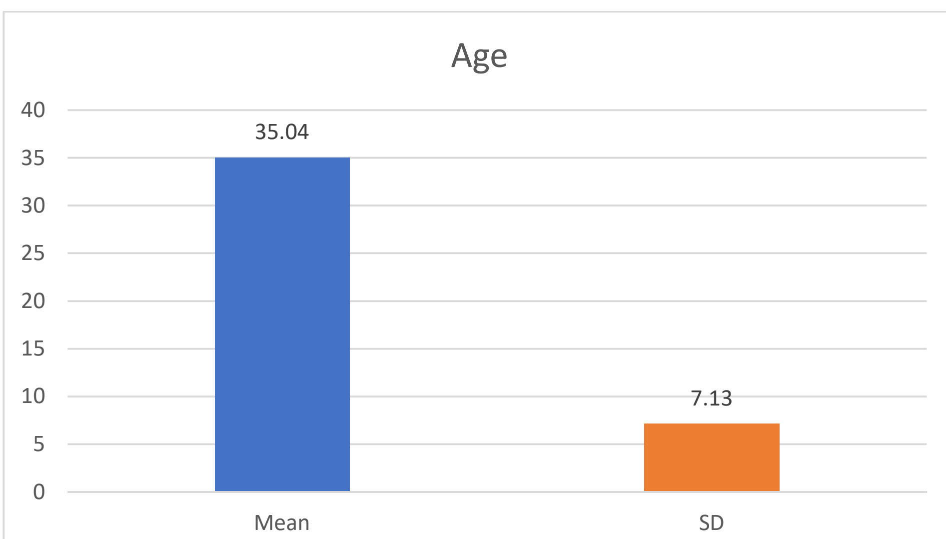


Descriptive Statistics

Variable – Age

Table no 2

Variable	Minimum	Maximum	Mean	SD
Age	23.00	50.00	35.04	7.13



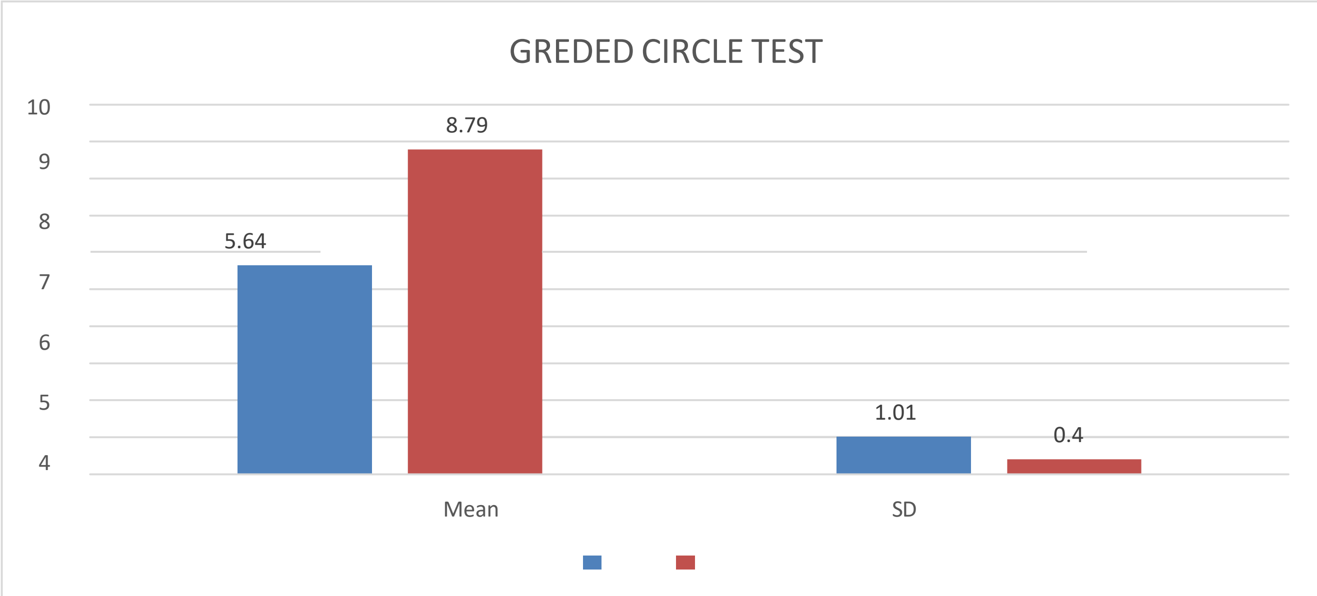
Within group Pre and post test

Times	Mean	SD	Mean Diff.	SD Diff.	Effect size	z-value	p-value	MCID
Pre	5.64	1.01	3.18	0.90	3.55	5.862	0.001*	0.19
Post	8.79	0.40						

Comparison of pre-test and post-test scores of GREDED CIRCLE TEST by paired sample Wilcoxon test

MCID was derived by multiplying the SD Diff. by the square root of 0.05 (5% significance level)

The standard deviation demonstrates the consistency with the post-treatment value, which is lower than the pre-value, and the mean value indicated changes post-treatment, with greater values being recorded for post-treatment outcomes. According to the usual parameters of reference, the effect size, or Cohen's D, suggests a value of 3.55, which is deemed to be extremely large. The test analysis results at a significance level of 5% indicate that there is a statistically significant and reliable difference between the pre and post treatment values. The p-value is less than the 5% significance level, or 0.001 < 0.05), which supports the improvements in the health outcome following the intervention. The minimum change in an outcome that a patient or a clinician would deem significant is represented by MCID. The result is validated as significant because the MCID value is 0.19, which is less than 0.75. The pre-post treatment mean difference value in the above table is greater than the minimal Clinically Important Difference, which means that the medical outcome is validated from both a statistical and medical standpoint because the difference values exceed the minimum required values as specified by the standards.



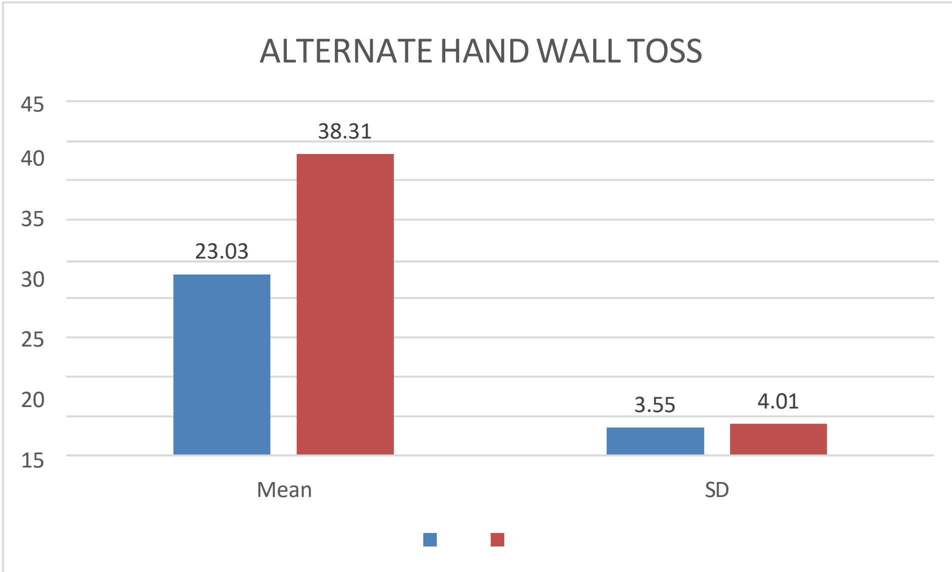
Within group Pre and post test

Comparison of pre-test and post-test scores of ALTERNATE HAND WALL TOSS by paired sample Wilcoxon test

Times	Mean	SD	Mean Diff.	SD Diff.	Effect size	z-value	p-value	MCID
Pre	23.03	3.55	15.30	2.79	5.48	5.789	0.001*	0.61
Post	38.31	4.01						

MCID was derived by multiplying the SD Diff. by the square root of 0.05 (5% significance level)

The standard deviation demonstrates the limited consistency with the post-treatment value, which is greater than the pre-value, while the mean value revealed changes post-treatment and higher values are recorded for post-treatment outcome. According to the usual parameters of reference, the effect size, or Cohen's D, suggests a value of 5.48, which is deemed to be extremely high. According to the test analysis's findings at the 5% significance level, there is a he study's p-value for the significant statistically reliable difference between the pre- and post-treatment values is less than the 5% significance level, or 0.001 < 0.05), which supports the improvements in the health result following the



intervention. The minimum change in an outcome that a patient or a clinician would deem significant is represented by MCID. The result is validated as significant because the MCID value is 0.61, which is less than 0.75. In the above table it is observed that pre-post treatment mean difference value is greater than the minimal Clinically Important Difference and hence it validates the medical outcome from both the statistical and medical perspective since the difference values are greater than the minimum required values as defined by the standards.

DISCUSSION

The study population consisted of 44 patients with impaired depth perception and eye hand coordination with vertigo which includes 24 males and2 0 females. The age group varies from 23 to 50 years in which mean age is 35.04 and standard is 7.13. The study's objective was to determine how virtual reality affected vertigo sufferers' perception of depth and hand-eye coordination.

The Graded Circle Test and the Alternate Hand Wall Toss were the two outcome measures employed in the study. The results of the statistical analysis support the improvements in health outcomes following the intervention, since there is a substantial statistically reliable difference between the pre and post treatment values, with a p-value less than the study's 5% significance level (i.e., $0.001<0.05$).

The depth perception was measured using the Graded Circle Test in this study before and after the intervention. The results indicate a substantial improvement in depth perception following the intervention, with a p-value of 0.001. Another study looked at the relationship between performing a basic laparoscopic skill and having a fundamental deficiency in depth perception. In that study comparable results were shown in pre- to post training scores by with depth perception defect students and those without depth perception defect, indicating that both groups benefited equally from the learning process. Because of this, students with depth perception defects start at a lower skills performance point and nonetheless gain basic laparoscopic abilities at a rate that is similar to that of students without depth perception defects. Further research is necessary to determine whether greater experience will enable both groups to achieve the same skill levels and whether this will translate into equivalent performance during actual surgical procedures. The goal of the current study is to shed more light on how well depth perception functions in virtual worlds. Our goal was to determine whether depth perception can be reliably and satisfactorily achieved in basic virtual environments with fewer depth cues, and if not, how to enhance depth impression without adding more possibly confusing secondary depth cues to the virtual world.[4]

The eye-hand coordination was assessed using the Alternate Hand Wall Toss in the given study before and after the intervention. The results indicate a significant improvement in eye-hand coordination after the intervention (p-value = 0.001). According to a study on the validity of the Alternate Hand Wall Toss, coordination is the ability to control muscular movements via the neurological system and motor organs. "Eye-hand coordination" refers to the method by which the brain decodes visual information from the eyes and efficiently guides hand movements. The Alternate Hand Wall Toss (AHWT) test is a common evaluation method in sports medicine for determining eye-hand coordination. The complexity of the exam instruments is one crucial factor that successfully contributes to determining topic ability.[2]

Many tests have been altered to better suit the qualities of the people since tests that are easy or tough cannot accurately assess subject abilities. The AHWT is a test instrument for assessing hand-eye coordination.[3]

A second study looked for a correlation between the results of the spinal manipulative therapy assessment and either general self-efficacy or hand-eye coordination. They come to the conclusion that a student's overall self-efficacy may be related to the outcomes of a spinal manipulative therapy exam. While the alternate-hand wall-toss test and spinal manipulative therapy scores did not correlate, there may have been one with other indications of homeostasis. The inconsistent results could be explained by the possibility that the Alternate Hand Wall Toss is not a suitable test for the abilities employed.[10]

Another study examines the impact of boxer-performed mental exercise on athletes' dynamic balance, eye-hand coordination, and visual attention. Visual skill training is a discipline that is heavily involved in brain workouts. The literature, which demonstrates that all activities, including mental exercises and similar visual training, have a positive effect on hand-eye coordination, supports the findings of our study. Acute and targeted exercise is found to increase hand-eye coordination, based on a review of conducted studies. The connected investigation on the effects of hand-eye coordination on balance and hand-eye coordination in the elderly indicated that swimming exercises had positive effects on hand-eye coordination.[11]

The purpose of the study was to evaluate the effects of virtual reality on vestibular rehabilitation for patients with peripheral vestibular dysfunction and vertigo. The results showed that virtual reality vestibular therapy was just as successful as traditional rehabilitation, leading to significantly higher patient satisfaction ratings. Introducing a sensory conflict through the use of next- generation VR goggles was found to boost patients' compensation mechanisms, and this innovative therapy is highly tolerated. Notably, none of our participants reported experiencing any side effects from the administered therapy. These might have included feelings of motion sickness, which have been documented in previous VR studies. To evaluate the effectiveness of this kind of treatment, the degree of vertigo was looked at.[5]

CONCLUSION

The current investigation found that individuals with vertigo significantly improved in their ability to perceive depth and their eye-hand coordination.

Declaration by Authors

Ethical Approval: Approved

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Conflict of Interest: The authors declare no conflict of interest.

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