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Effect of Virtual Reality Based treatment in Geriatric Population on Static Balance, Dynamic Balance and Risk of Fall

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ABSTRACT

Background: With advancing age, the postural control mechanism becomes less efficient due to ageing. Reduced peripheral sensation, muscle weakness, and increased reaction time are significant contributing factors to postural instability in the elderly. Thus age can affect both static and dynamic balance in elderly which will eventually have impact on fear of fall and risk of fall. Virtual Reality Training (VRT) focuses on exercise intensity and feedback that provides the patient with safe and effective training and rehabilitation. The aim of this study is to evaluate the effects of kinect based virtual reality training on Static balance, Dynamic balance and Risk of Fall.

Methodology: Ethical clearance was obtained by the Ramaiah Medical College and Hospitals. Based on the inclusion criteria, patients were screened using Time up and go test (TUG) as a screening tool for balance, 31 participants were recruited. Pre and post assessment of static and dynamic balance was done by Four Stage Balance Test (FSBT) and TUG. Explanation and instruction were given to patient about the game controls and exergames with a demo.

Results and Conclusion: 30 min of Exergame training for 8 sessions for two week were administered. Paired t-test was used to test for significant change. Pre-post comparison of TUG and FSBT scores showed that there is significant change. ($p = <0.001$ and <0.001 respectively which is statistically significant).VRT can be an effective means of training basic motor skills to improve the balance, and use of VR in the area of motor learning can be of great benefit in improving balance.

Keywords: Exergames; Virtual Reality Training; Virtual Rehabilitation; Balance; Risk of fall; Geriatrics

I. INTRODUCTION

Ageing affects the nervous system as well as other systems of our body. When people age, they suffer from lack of memory and have difficulties to learn, it can also make them lose balance. With advancing age, the postural control mechanism (balance) becomes less efficient because of changes

in its individual components of different body system such as Musculoskeletal, Cardiovascular and Neurological systems[1]. Changes have been reported in muscle response strategies in older adults during balancing activities; the somatosensory, vestibular, and visual systems have also shown a reduction in function. Reduced peripheral sensation, muscle weakness, and increased reaction time are significant contributing factors to postural instability in the elderly population. Thus age affects the balance in elders. Both static and dynamic balance can be affected. Balance is considered a complex motor skill necessary for functional performance of the individual, especially in daily living activities. Balance relies on proprioceptive, vestibular and visual system inputs which are processed by the central nervous system, requiring the integrated functioning of sensory, motor and cognitive systems. Exercise can be used as a stand-alone falls prevention intervention or as a component of a multifaceted program. Multifaceted interventions can prevent falls in the general community, in those at greater risk of falls, and in residential care abilities. In recent years, technological improvements have allowed for the creation of Virtual Reality (VR) environments for different uses, especially in the training of pilots, astronauts, medical staff, soldiers, and athletes. In regards to physical activity, V.R. is currently being used in two main fields: Exergaming and Rehabilitation[2]. The use of video games with a VR device has been gaining ground in rehabilitation processes. VR refers to a simulated interactive environment. According to Leon et al. VR aims to create a visual, auditory and sometimes tactile and olfactory environment that appears real and enables the human user to become immersed in the interactive experience[3].leon et al Problems of elderly population in balance treatment are adherence, compliance to the exercise and physical limitation of exercises (ROM, Strength and Endurance) Hence, Kinect based Virtual Reality Training (VRT) can be an alternate treatment for balance in elderly population. As VRT has advantages over the other forms of interventions such as, home situation, monitoring performance, external focus of attention, personalized, training both motor control and cognitive function as well, it is also motivational and engaging[4]. The use of Xbox in urban population is affordable and convenient. Kinect based events are commonly available consumer device games inbuilt into system, and can be used in home setup rather than going out of the home which can be problem of commute. Aim of the study is to know the effect of VRT on static balance and dynamic balance in geriatric population and to know the effect of VRT on risk of fall in geriatric population Indian urban set up.

II. METHODS

The Study Design is case series, Study Type is pre-post design, and Study Setting was set up at Physiotherapy rehabilitation center, Ramaiah Memorial hospital. The Participants who were included in the study were elderly Individuals with impaired balance above 60 year in the community, Sampling Design was Convenient sampling. Source of participants were community dwellers from M.S.R Nagar, Bangalore. Ethical Clearance was obtained from M.S Ramaiah Medical college and Hospital (EC/433/2017). Sample Size Determination was 19 samples[5]. Sample size was calculated using the data from the reference article Seline Wuest, 2014. Material were used the material used to set up VRT set up were TV/ projector, Xbox 360 console, Kinect device, Kinect Exergames (sports and adventure), Joystick (controller) and a Laptop. Inclusion criteria for the study were people above the Age 60-80 (male and female), people with impaired balance, people Able to walk without any assistive device, MMSE

score 24 and above, Diabetic and Hypertensive under medication. Exclusion criteria for the study were- People with Vestibular disorders, Visual disorders, seniors with Cognitive decline, chronic cardiac, orthopedics, and neurological conditions seniors with a serious fall event that led to medical attention (fracture) within 1 year prior to the start of the study.

Outcome Measures used were four stage balance test for Static balance, Timed up and go test for Dynamic balance and Time up and go test for Risk of fall

PROCEDURE:

Ethical clearance was obtained. Written consent form from each participant was obtained. Screening of the subjects was done to select according to inclusion criteria. Pre intervention outcome results were obtained. Explanation and understanding of VRT was given to patients with a demo. Thirty minutes of virtual 8 sessions of VRT intervention involving exergaming activities. Pre assessment for static and dynamic balance will be done by screening test (TUG test) and patients will be explained in detail about the exergames and set up. Clear instruction will be given to patient about the game controls with a demo. 30 min of exergames training for 8 sessions will be done and at the end of 8 sessions, post intervention assessment for static and dynamic balance data will be collected and results will be drawn from the outcome measure data obtained post intervention in the study.

STATISTICAL ANALYSIS:

Statistical software SPSS 16 was used for analysis and Microsoft Word and Excel were used to generate tables and graph. The normality of the data was confirmed using Shapiro Wilk Test

III. RESULTS

2 weeks of VRT training for 8 sessions showed an significant improvement in both static and dynamic balance. Time taken to complete TUG pre-test with mean 13.42± 1.36 reduced to 12.12±1.10 sec. and this shows reduction in time for Tug which implies that there will be improvement in dynamic balance and risk of fall. On the other hand there is increase in time taken to perform FSBT post intervention and with mean time pre-test 5.14±2.59 increased to 8.52±2.09 sec. this shows improvement in the FSBT scores which implies that there is improvement in static balance. Post intervention data shows significant improvement in both TUG and FSBT with $p<0.001$.

	TUG pre	TUG post	FSBT pre	FSBT post
MEAN	13.42 ± 1.36s	12.12 ± 1.10	5.14 ± 2.59	8.52 ± 2.09
SEM	0.31	0.25	0.59	0.48

Table 1 Descriptive data about the patient pre and post values in time (seconds) both outcome measures

Outcome measures (N= 19)	Pre Mean ± SD	Post Mean ± SD	Pre-Post Difference Mean ± SD	p value	95% Confidence Interval		Effect Size
					Upper	Lower	
FSBT	5.1 ± 2.59	8.52 ± 2.09	3.37 ± 2.7	0.001	2.31	4.47	1.52
TUG	13.42 ± 1.36	12.13 ± 1.1	1.29 ± 0.55	0.001	1.56	1.02	1.83

Table 2 summarizing result values of Student's paired t-test For FSBT and TUG which suggests the significance. (P< 0.05 denotes statistically Significant difference)

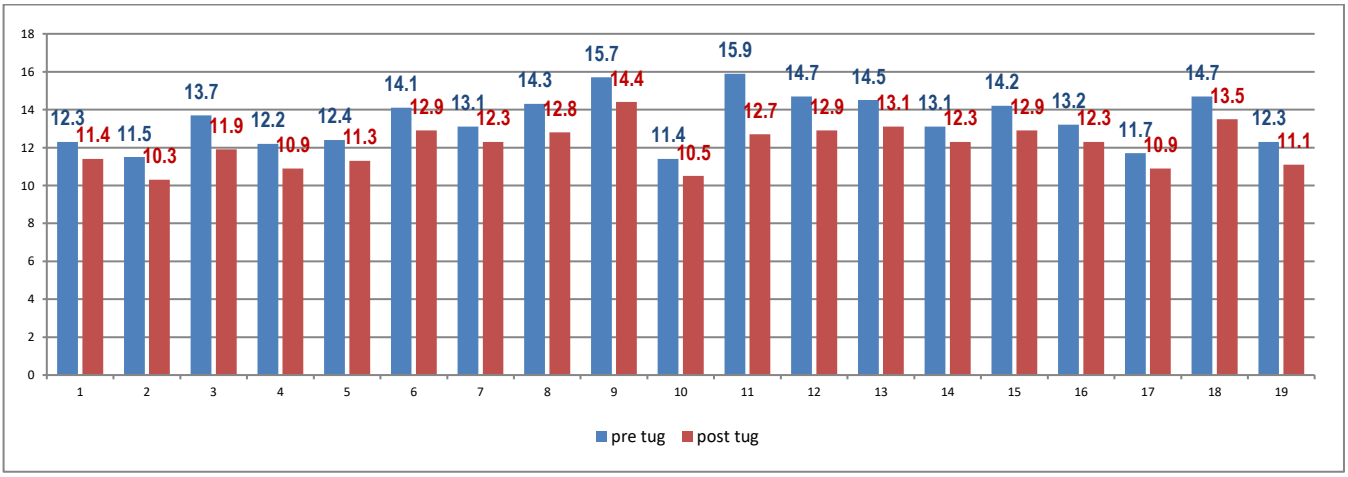


Figure 1(a) showing the data for pre Tug test and post Tug test in second (X axis represents the number of samples and y axis represents the time taken in seconds to complete the TUG test)

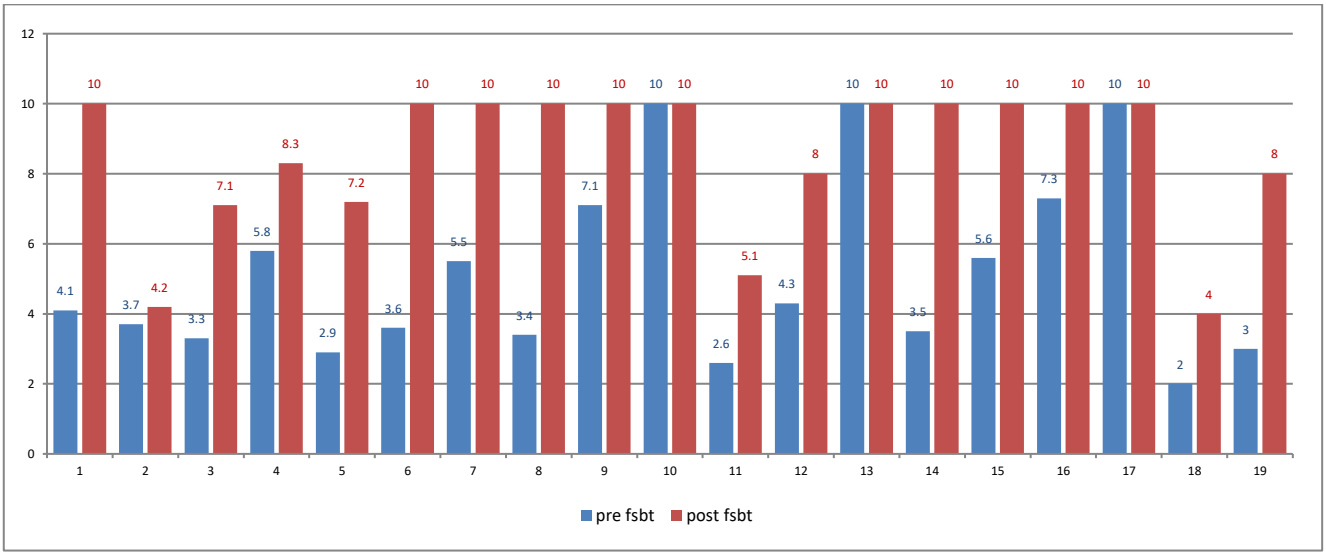


Figure 1(b) showing the data for Four step balance test pre and post values in seconds (X axis represents the number of samples and y axis represents the time taken in seconds to complete the FSBT Test)

DISCUSSION:

The VR system can be categorized as immersion and non-immersion. In the immersive system, the person is encapsulated in the virtual environment and all of their senses (vision, touch and auditory) are blocked from the external environment. Where as in the non-immersive system the person senses are intact with the external world. Some of the input devices which can be used in VR are the computer mouse; a data glove and in some cases position trackers[6]. The output devices may be computer and/or television screens, shutter glasses or head-mounted displays. The elements of motor learning theory are integrated in VR intervention because it enables the users to gain feedback, thereby monitoring their performance, which is more likely to result in repeated practice. Cortical reorganization (brain learning), a systematic review found that more than half of the reviewed studies reported desirable results in brain plasticity and brain reorganization with the use of VR[7]. Active participation, receiving feedback, and repetition of movements assisted in motor learning and related cortical changes. Neural plasticity through cortical reorganization following VR intervention was also reported.

This study demonstrates the use of virtual reality training in elderly to motivate subjects during the target oriented task and therefore contributing to the augmented rehabilitation. VRT Exergames have task difficulty control and task velocity adjustment. VRT helps subjects to engage with motivation and fully cooperate with the task which may enhance the rehabilitation outcome measures and also on the other hand allow creating a virtual environment where task constrains can be modified and also supervised. This is the reason that the studies mentioned in literature review seem to be overlapping with this study but these studies are done using different modes of exergames. For instance, one of study used balance board for exergames as controller, whereas the study used only one single exergame which was skiing where participants have to only control with lower body. Other study used a Balance rehabilitation unit (BRU) is software which is made specifically virtual games to improve balance and it is expensive for people to use commercially[8]. This study aims to use the commercially available exergames using kinect device which makes the body itself as a game controller, where participants can perform different activity as virtual tasks. The use of VRT in developed countries have a upper hand as they are well versed with technology and can easily understand the working of program so it can be the one of the reason for the positive outcome. Contrary to this since India is a developing country VRT and technology is not in main stream in an Indian scenario.

As discussed earlier that, there are many conventional balance training programs for the geriatric population but some limitation such as adherence , compliance and physical limitation of exercise which will hinder the effects of balance training. And thus, participants in the VRT were highly motivated by the challenge, variability and the competitive factors. VR Improved cognitive function, concentration and levels of participation during VR intervention. It provides feedback which enables the participants to improve their performance by repetition, cognitive planning, and by giving them a sense of achievement. The VR environment can allow creativity, it has been shown to have resulted in improved persistence with repetitive tasks; increased enjoyment in attaining the therapeutic objective; and it gives the participant a certain degree of control[9]. VRT serves as a alternative preventive measure against age related issues and disability, the existing evidence supports the use of home based VRT for improving age related impaired balance in elderly.

Feasibility and effectiveness of VR/gaming systems use by older adults at home to enable physical activity to address impairments, activity limitations and participation. Although it is clear that VR systems rely on hardware and software, their use in all rehabilitation situations requires clinicians to make decisions about the appropriateness of the intervention for the patient, implementation of treatment parameters and progression through different levels of the game or task.

CONCLUSION

This study concludes that the change in balance is one of the largest factors for falls in the elderly, and lack of balance and fall occurrences have a high correlation. Dynamic balance exercise in particular can reduce the fall risk factor significantly. In this regard, the effect of introducing virtual reality based interventions is positive, because they can provide immediate visual and auditory feedback concerning the exercise results, thereby increasing the exercise learning effect. This suggests the possibility of using virtual reality based games for a broad range of exercise applications.

IV. Annexure

FIG 4: SPACE POP

FIG 5: RIVER RUSH

FIG 6: WATER PLUGS

FIG 7: 100 METER SPRINT

FIG 8: DISCUSS THROW

FIG 9: JAVELIN THROW

PARTICIPANT SCREENING CHECKLIST

Study Title: Effects of kinect based Virtual Reality Training in Geriatric population on balance.

Patient ID No.:
Age/Gender.:

Inclusion Criteria:

1. Age from 65-80 ☐
2. TUG test score >13.5. ☐

Exclusion Criteria:

1. MMSE < 24 ☐
2. Late Elderly (>80 years of age.) ☐
3. Significant impairment due to other neurological Conditions or orthopedic conditions. ☐

YES ☐ NO ☐

Patient fulfilled the inclusion criteria: Consent for participation n ☐ ☐

study obtained ☐ ☐

DATA COLLECTION SHEET

Demographic Data:

Age:
Gender:
Co morbidities Medications and dosage:

OUTCOME MEASURE	**Pre intervention Data**	**Post intervention Data**
4 stage balance test		
TUG		

Game Score Sheet.

Sl. NO	GAME	SESSION 1	2	3	4	5	6	7	8
1	Water plugs								
2	Space pop								
3	100m sprint								

4	Javelin throw								
5	River Rush								
6	Discus Throw								

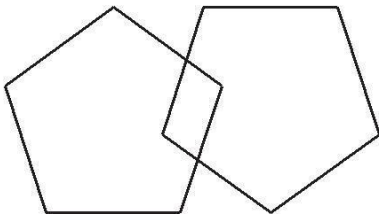
Examiner

The Mini-Mental State Exam

Patient_____ Examiner _____ Date _____

Maximum Score 30

Orientation



5 ( ) What is the (year) (season) (date) (day) (month)?

5 ( ) Where are we (state) (country) (town) (hospital) (floor)?

Registration

3 ( ) Name 3 objects: 1 second to say each. Then ask the patient all 3 after you have said them. Give 1 point for each correct answer. Then repeat them until he/she learns all 3. Count trials and record.

Trials _____

Attention and Calculation

5 ( ) Serial 7's. 1 point for each correct answer. Stop after 5 answers. Alternatively spell "world" backward.

Recall

3 ( ) Ask for the 3 objects repeated above. Give 1 point for each correct answer.

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