REVIVING MOBILITY: EXPLORING VIRTUAL REALITY VERSUS TRADITIONAL TRAINING FOR UPPER LIMB REHABILITATION IN STROKE SURVIVORS

A. AYYAPPAN[1*] AND P. NAGALAKSHMI[2]

1: PhD, Research Scholar, PG and Research Institute of Rehabilitation science, Holycross College, Affiliated to Bharathidasan University, Trichy, Tamilnadu, India

2: PhD. Associate Professor, PG and Research Institute of Rehabilitation science, Holycross College, Affiliated to Bharathidasan University, Trichy. Tamilnadu, India

*Corresponding Author: Dr. A. Ayyappan: E Mail: ayyappan.ayyappan9@gmail.com

ABSTRACT

Aim: This study finds the effectiveness of virtual reality versus conventional training on improving upper limb functional activities in post stroke patients.

Background: In recent years, efforts have been made to implement virtual reality (VR) to support the delivery of post stroke upper extremity motor rehabilitation exercises as the existing research evidence.

Objective: This study examined the effectiveness of using VR supported exercise therapy showed significant improvement than conventional training for upper extremity task specific motor rehabilitation in patients with stroke.

Methods: Changes in outcomes related to impairments in upper extremity functions and structures, activity limitations, and participation restrictions in life situations from baseline to after intervention, follow-up assessment were examined. Standardized mean differences (SMDs) were calculated using a random-effects model. Subgroup analyses were performed to determine the

differences in treatment outcomes depended on age, stroke recovery stage, VR program type, therapy delivery format, similarities in intervention duration between study groups, VR groups, and trial length.

Results: 50 trials were analyzed. Compared with the control group conventional therapy, the intervention group VR supported exercise therapy shows significant improvements in upper extremity motor function.

Conclusions: VR-supported upper extremity exercise therapy can be effective in improving motor rehabilitation. Review showed that 12 rehabilitation outcomes examined during the course of VR-based therapy, significant improvements were detected in 2 (upper extremity motor function and range of motion), and both significant and non-significant improvements were observed in another 2 (muscle strength and independence in day-to-day activities), depending on the measurement tools or methods used.

Keywords: VR-supported upper extremity ADL facilitation

INTRODUCTION

DISABILITY

Disability is defined as the "Functional loss due to permanent physical impairment resulting from congenital condition, disease or trauma". It excluded illness/injury of recent origin (morbidity) resulting into temporary loss of ability to see, hear, speak or functional abilities

Disability results from the interaction between individuals with a health condition, such as cerebral palsy, Down syndrome and depression, with personal and environmental factors including negative attitudes, inaccessible transportation and public buildings, and limited social support.

A person's environment has a huge effect on the experience and extent of disability. Inaccessible environments create barriers that often hinder the full and effective participation of persons with disabilities in society on an equal basis with others. Progress on improving social participation can be made by addressing these barriers and facilitating persons with disabilities in their day to day lives.

World Health Organization's (WHO) International Classification of Functioning, Disability and Health (ICF), uses 'disability' as an umbrella term for any or all of the following components:

• Impairments - problems in body function or structure

• Activity limitations - difficulties in executing activities

• Participation restrictions - problems an individual may experience in involvement in life situations.

VIRTUAL REALITY

Upper limb motor impairment following stroke is a common condition that impacts significantly the independence and quality of life of stroke survivors. In recent years, scholars have massively turned to virtual reality (VR) to develop more effective rehabilitation approaches. VR systems are promising tools that can help patients engage in intensive, repetitive and task-oriented practice using new technologies to promote neuroplasticity and recovery. The use of virtual ADL practice as a tool for UE therapy for stroke patients [1].

Multiple studies have found significant improvements in upper limb function for patients using VR in therapy, but the heterogeneity of methods and tools employed make the assessment of VR efficacy difficult. The effectiveness is proved in Rehabilitation-Oriented Virtual Reality Device in Patients with disability in Early Subacute Recovery Phase [2].

`In an effort to assist these individuals with motor recovery, virtual reality (VR) systems were developed. VR is defined as a "computer-based technology that allows users to interact with a multisensory simulated environment and receive 'real-time' feedback on performance".The interactive games are designed to provide the patient with real-life scenarios and activities relevant to daily living [3-5]. The software is able to provide key concepts required for motor learning including frequency, intensity, repetition and task-oriented training while enabling the user to feel involved in their rehabilitation.It prevent learned nonuse of affected side [6-7]. These systems have many settings that allow accommodation for patient needs, abilities and goals through the manipulation of the degree of difficulty, focus on the extremity of choice as well as options for game tasks.virtual reality may be applied either for individuals or applied in group therapy compared with specific task performance get good result in group therapy. **Figure 1.1 & 1.2** explains the iteration of the patients in group therapy. Application of typical elements of game playing (e.g. point scoring, competition with others, rules of play) to other areas of activity. Gamification in stroke treatment offers significant benefits by enhancing patient engagement, motivation, and adherence to long term rehabilitation programs [8-10].

Figure 1.1

Figure 1.2

NEED FOR THE STUDY

There are many different intervention for improving upper limb functions in hemiplegic patients. This study is designed to find out the effectiveness of virtual reality versus conventional training on improving upper limb function in hemiplegic patients. There is little evidence for the effectiveness of virtual reality versus convention training on improving upper limb function. So it is necessary to study the effectiveness of virtual reality versus conventional training on improving upper limb function.

METHODOLOGY

This study was conducted by using Quazi experimental research design. A sample of 50 subjects were selected using convenient sampling method. 25 samples were randomly allocated in both control and experimental group. Samples were selected based on the selection criteria, inclusion criteria includes both male and female with age range of 17-50, with ischemic stroke.

The study was conducted at Aarogya Physiotherapy Rehabilitation Centre, Erode. Informed consent was obtained from all the participants. The study period was 45 minutes per session, 2 sessions per day, 6 days per week. The study was conducted the total duration of 24 weeks (6 months).

Virtual reality was scheduled on the treatment duration to each patient in the experimental group. After six months post test was conducted with FIM Scale and modified barthel index scale.

LIMITATIONS:

➤ As only small sample size is included in this study, the result cannot be generalised

➤ Patients with age 17-50 years were only taken for the study.

➤ It's very difficult to conduct the study with non-dominant hemisphere lesion.

➤ The patient with cognitive and perceptual disorder is very difficult to handle the skill based activity.

➢ The patient with any co morbid conditions like hypertension, vertigo degenerative disorders of spine and other joints.

MEASUREMENT TOOLS

Modified Barthel Index

The Modified Barthel Index (MBI) is used to measure a person's level of independence in activities of daily living (ADLs), with more detailed scoring to increase sensitivity and reduce ceiling effects.

Each item is scored on a scale, the total MBI score ranges from 0 to 100 depending on the activity and the level of assistance **Table 1.1** explains higher scores indicate greater independence level. Each activity is assigned task based on its importance to daily functioning. (Minimum score = 0 indicates complete dependence. Maximum score = 100 indicates complete independence in physical functioning).

Table:1.1: Modified Barthel Index

Total score	Interpretation
00-20	Total Dependence
21-60	Severe Dependence
61-90	Moderate Dependence
91-99	Slight Dependence
-100	Independence

Functional Independence Measure Scale

Parameter consist of self-care, sphincter control, transfers, locomotion, communication, social cognition Each item is scored on a 7point ordinal scale, ranging from a score of 1 to a score of 7. The higher the score, the more independent the patient is in performing the task associated with that item.

FIM levels

No Helper

- Complete Independence (Timely, Safety)
- Modified Independence (Device)

Helper - Modified Dependence

- Supervision (Subject = 100%)
- Minimal Assistance (Subject = 75% or more)
- Moderate Assistance (Subject = 50% or more)

Helper - Complete Dependence

- Maximal Assistance (Subject = 25% or more)
- Total Assistance or not Testable (Subject less than 25%)

Leave no blanks. Enter 1 if not testable due to risk.

The total score for the FIM

- motor subscale (the sum of the individual motor subscale items) will be a value between 13 and 91.
- cognition subscale (the sum of the individual cognition subscale items) will be a value between 5 and 35. The total score for the FIM instrument (the sum of the motor and cognition subscale scores) will be a value between 18 and 126.

TREATMENT TECHNIQUES

Procedure

➢ The selected patients received clear explanation about the treatment procedure prior to the study.

➢ The written informed consent form was received before the intervention began.

➢ The participants received interventions with a target of 6 training sessions per week for 6 months of up to 45 minutes duration and 2 sessions per day .

➢ The pre and post test values were taken by using Functional independence measure and Modified Barthel index

➢ Designated research therapists provided both the VR training and the CT as an addition to standard rehabilitation. The amount of physicaltherapy provided was registered for each patient.

DATA ANALYSIS & INTERPRETETION

In this study involving 50 patients, with 25 in the experimental group **(A)** & 25 in the control group **(B)** the experimental group receiving the treatment showed significantly greater improvement in upper extremity function compared to the control group across all 50 trails**. Table 1.2** presents the outcome measures of iteration of experimental group **(A)**, **Table 1.3** presents the outcome measures of iteration of control group **(B)** shows significant improvement in the upper extremity gamification.

Table1.2 Group A (Experimental Group)

| Outcome Measure	Pre & Post Test Value	Mean	Mean Diffrence	Standard Deviation	Calculated "T" Value
Functional Independence Measure	Pre Test	48.64	6.28	1.127	27.86
	Post test	54.92			
Modified Barthel Index	Pre test	47.92	6.52	0.5	66
	Post test	54.44			

Table:1.3 Group B (Control Group)

| Outcome Measure	Pre & Post Test Value	Mean	Mean Diffrence	Standard Deviation	Calculated "T" Value
Functional Independence Measure	Pre Test	47.76	3.24	0.830	19.51
	Post Test	51			
Modified Barthel Index	Pre Test	49.68	3.28	1.307	12.54
	Post Test	52.96			

Graphical Representation:

Graph. 1.1, explains the graphical presentation of Functional independence measures shows the significant improvement in Experimental group (**A**) compared with Control Group (**B**), Whereas **Graph. 1.2**, explains the graphical presentation of Modified Barthel index shows the significant improvement in Experimental group (**A**) compared with Control Group (**B**).
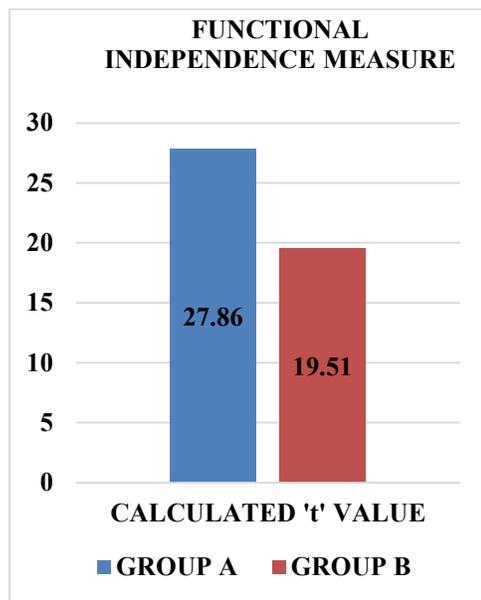
Graph 1.1
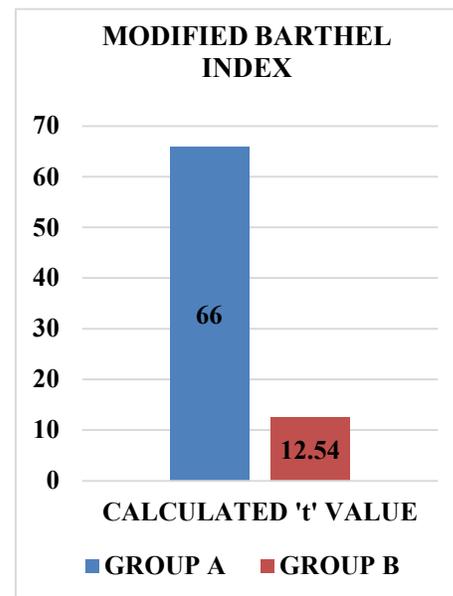
Graph 1.2

RESULTS

Functional Independence Measure Scale

The calculated 't value for the experimental group (A) is 27.86 where as for the control group(B) the calculated 't value is 19.51. Since the calculated value between both the groups exhibits a clear difference that is the control group has less value than the experimental group Hence, Null hypothesis is rejected and alternate hypothesis accepted.

Modified Barthel Index scale

The calculated 't value for the experimental group is 66 whereas for the control group the calculated 't value is 12.59.

Since the calculated value between both the groups exhibits a clear difference that is the control group has less value than the experimental group Hence, Null hypothesis is rejected and alternate hypothesis accepted

DISCUSSION

The aim of the study was to find the effectiveness of Virtual reality versus conventional training among post stroke patients on improving upper limb functional activities has been proved. Patient showed changes in their upper limb functions considerably during the study period.

In this study, functional independence of the patient was measured by functional independence measure and modified barthel index scale. This study showed that "There was statistical significant difference in the post test mean and the pre test mean."

The gamification of VR rehabilitation interventions is believed to motivate patients to actively participate with pleasure thus increasing the tasks performed and augmenting their recovery. When participants are more interested, they are more concentrated and more persistent in completing their tasks. Certain benefits in psychological outcomes should always be acknowledged as a positive component, especially in neurological patients who often are faced with a long recovery [5]. Our results

are in agreement with those of previous systematic reviews or narrative ones that have examined semi-immersive VR interventions [6, 7] and with a scoping review that assessed the application of HMD in adult physical rehabilitation [8]. The authors did state that the use of HMD as a low-cost, portable tool seems to have additional benefits, but the generalization of the findings is yet to be discussed due to the relatively low level of evidence and the small number of participants [9]. Another key aspect noted also by [10] is the additional benefits of incorporating VR in conventional rehabilitation, such as motivation and engagement.

RECOMMENDATION

- ➢ Other conditions such as cerebral palsy with lack of upperlimb motor control also be treated by using virtual reality and conventional training
- ➢ The Study was carried out for a short duration, long term study is recommended for further exploration.
- ➢ We can conduct the study with traumatic brain injury patient.
- ➢ It's is a objective based exercise it improves skills and activity in physically and mentally disabled patients.

SUMMARY AND CONCLUSION

On average, VR or gaming interventions produced a maximum improvement of the possible improvement that could be achieved . Dose and severity of motor impairment did not significantly influence rehabilitation outcomes. Treatment gains were significantly larger overall when the computerized training involved a gaming component with just visual feedback. VR or gaming interventions showed a significant treatment advantage over active control treatments.

Overall, VR- or gaming-based upper extremity rehabilitation poststroke appears to be more effective than conventional methods. Further in-depth study of variables affecting improvement, such as individual motor presentation, treatment dose, and the relationship between them are needed.

REFERENCE

[1] Adams, R. J., Lichter, M. D., Ellington, A., White, M., Armstead, K., Patrie, J. T., *et al*. (2018). Virtual Activities of Daily Living for Recovery of Upper Extremity Motor Function. IEEE Trans. Neural Syst. Rehabil. Eng. 26 (1), 252–260. doi:10.1109/TNSRE.2017.2771272.

[2] Ahmed, N., Mauad, V. A. Q., Gomez-Rojas, O., Sushea, A., Castro-Tejada, G., Michel, J., *et al*. (2020). The Impact of Rehabilitation-Oriented Virtual Reality Device in Patients with Ischemic Stroke in the Early Subacute Recovery Phase: Study Protocol for a Phase III, Single-Blinded, Randomized, Controlled Clinical Trial. J. Cent. Nerv Syst. Dis. 12, 117957351989947. doi:10.1177/1179573519899471.

[3] Ain, Q. U., Khan, S., Ilyas, S., Yaseen, A., Tariq, I., Liu, T., *et al*. (2021). Additional Effects of Xbox Kinect Training on Upper Limb Function in Chronic Stroke Patients: A Randomized Control Trial. Healthcare 9 (3), 242. doi:10.3390/healthcare9030242.

[4] Allegue, D. R., Kairy, D., Higgins, J., Archambault, P., Michaud, F., Miller, W., *et al*. (2020). Optimization of Upper Extremity Rehabilitation by Combining Telerehabilitation with an Exergame in People with Chronic Stroke: Protocol for a Mixed Methods Study. JMIR Res. Protoc. 9 (5), e14629. doi:10.2196/14629.

[5] Aminov, A., Rogers, J. M., Middleton, S., Caeyenberghs, K., and Wilson, P. H. (2018). What Do Randomized Controlled Trials Say about Virtual Rehabilitation in Stroke? A

Systematic Literature Review and Meta-Analysis of Upper-Limb and Cognitive Outcomes. J. Neuroengineering Rehabil. 15 (1), 29. doi:10.1186/s12984-018-0370-2.

[6] Aşkın, A., Atar, E., Koçyiğit, H., and Tosun, A. (2018). Effects of Kinect-Based Virtual Reality Game Training on Upper Extremity Motor Recovery in Chronic Stroke. Somatosensory Mot. Res. 35 (1), 25–32. doi:10.1080/08990220.2018.1444599.

[7] Ballester, B. R., Maier, M., San Segundo Mozo, R. M., Castañeda, V., Duff, A., and M. J. Verschure, P. F. (2016). Counteracting Learned Non-use in Chronic Stroke Patients with Reinforcement-Induced Movement Therapy. J. Neuroengineering Rehabil. 13 (1), 74. doi:10.1186/s12984-016-0178-x.

[8] Ballester, B. R., Nirme, J., Camacho, I., Duarte, E., Rodríguez, S., Cuxart, A., *et al*. (2017). Domiciliary VR-Based Therapy for Functional Recovery and Cortical Reorganization: Randomized Controlled Trial in Participants at the Chronic Stage post Stroke. JMIR serious games 5 (3), e15. doi:10.2196/games.6773.

[9] Baniña, M. C., Molad, R., Solomon, J. M., Berman, S., Soroker, N., Frenkel-Toledo, S., *et al*. (2020). Exercise Intensity of the Upper Limb Can Be Enhanced Using a Virtual Rehabilitation System. Disabil. Rehabil. Assistive Tech., 1–7. doi:10.1080/17483107.2020.1765421.

[10] Bohil, C. J., Alicea, B., and Biocca, F. A. (2011). Virtual Reality in Neuroscience Research and Therapy. Nat. Rev. Neurosci. 12 (12), 752–762. doi:10.1038/nrn3122.