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Effects of Video Gaming and Conventional Physical Therapy on Upper Limb Rehabilitation in Stroke Patients: A Randomized Controlled Trial From Rafsan Neuro Rehabilitation Center, Peshawar

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ABSTRACT

Stroke is a neurological condition that significantly affects physical activities in adults requiring specialized and effective rehabilitation techniques. Globally stroke is the second leading cause of death in individual older than sixty years of age (Murphy and Werring, 2020). By 2019, women accounted death from stroke about 6.2% and male deaths 4.4% at average about 55,000 more fatal stroke occur in women than men each year. Many physical therapy interventions and other advanced techniques and technologies contribute in management of stroke (Lee, Choi and Jeoung, 2022). Video gaming (VG) is an evolving technology which has significant potential for use in various areas of rehabilitation, including stroke recovery. To determine the effectiveness of Video Gaming and Conventional Physical Therapy techniques on upper limb rehabilitation in stroke patients. To compare the effects of video gaming with conventional physical therapy technique on upper limb rehabilitation in stroke patients. This double blinded RCT study recruited 18 participants through census to evaluate patients admitted at Rafsan Neuro Rehabilitation Centre, Peshawar. Both the groups received independent rehabilitation programme. After data collection by using the Barthel Index scale, the data was analyzed in SPSS. The 18 participants were randomoly allocated into two equal group i.e Video Gaming (VG) group and Conventional Physical Therapy(CPT) group. In CPT group the total participants were 8 in which the male participants were 7 (87.5%) and female participant was 1 (12.5%). In VG group the total participants were also 8 in which the male participants were 6 (75%) and female participants were 2 (25%). Paired T test was applied for pre and post CPT assement in stroke patients rehabilitation, which showed that the P value was 0.214 which was greater than 0.05 and showed that there was no significant changes noted. For the VG assessment in stroke patients the Paired T test was applied which showed that the P value was 0.003 that was less than 0.05 and showed significant changes in post video gaming activity. We found that video gaming was more effective than conventional physical therapy in upper limb stroke rehabilitation. Video Gaming group showed significant improvement and good prognosis in comparison to the conventional physical therapy group in most of the variables of the Barthel Index scale.

INTRODUCTION

Stroke is the world's second biggest cause of mortality and could soon overtake the biggest cause of death globally. It occurs when the blood flow to a portion of the brain interrupted without essential oxygen and nutrients supplied by blood, brain cells began to die within minutes which can result in brain damage, persistent disability or in severe cases death. Individuals who had a stroke may experience a diverse range of physical, cognitive, emotional and behavioral issues, along with functional challenges in everyday activities. These difficulties can lead to decreased participation, integration and standard of living[1]. Rehabilitation plays an important role in stroke patients by promoting cortical reorganization, helps patients to recover their lost skills and develop compensatory techniques. Traditionally conventional physical therapy program were provided to restore motor functions and normal range of motion of muscles that includes Constraint-Induced Movement Therapy (CIMT), Motor Relearning Programme (MRP), Proprioceptive Neuromuscular Facilitation (PNF), passive range of motion exercises, gait and balance training exercises, stretching exercises, isometric exercises, strengthing of the weak muscles[2]. For the purpose of this study we gave PNF technique as part of conventional physical therapy, it is developed by physiotherapists as a method of rehabilitation in stroke patients and refers to any of several post-isometric relaxation stretching techniques. PNF asked for the muscle to be stretched again passively throughout the increased range of motion gained on each repetition. The main goal of is to target specific muscles group and increased flexibility[3]. VR or video gaming act on creating an artificial scenario and adopting it to the real world by applying sensory stimuli, it interacts, navigate and immerse in a three-dimensional space which is applied in two modes.

- In non immersive VR there is full awareness of the outside world.
- Semimmersive VR is the combination of VR technology and simulator based technology, with retained awareness of outside world[4].

A physiological reasoning behind these enhancements in physical condition rests on the functioning of mirror neurons. Rizzolatti, who unveiled mirror neurons, explain that this "mirror" process operates as such: whenever a person witnesses another performing an action, there are specific neurons responsible for encoding action that become active within the observer's motor system. Thus when an individual views a particular movement within a virtual reality setting, their motor level undergoes activation due to the activity of these mirror neurons[5]. VG is very interactive technique used in foreign countries enhancing motor recovery and functional outcomes compared to CPT technique. By leveraging the motivational and interactive elements of gaming, stroke patients may experience increased engagement, task specific training, intensity and feedback, ultimately leading to improved rehabilitation outcomes. In Pakistan the use of VG for post stroke patients is uncommon beside of its lots of benefits and early motor recovery. For this purpose, we thought to use the VG technique because it is most effective approach and had better prognosis rate than CPT technique on stroke patients, which will open a door of awareness among health professionals as well as provide its outcomes about the use of this new rehabilitation technique.

MATERIALS AND METHODS

Study Design: This was a double blinded parallel RCT study in which both groups were provided with the independent rehabilitation program. This study was a type of experimental study. The sample size was 18 calculated through census. Census is done when the population is too large or too small. Data was collected from all the stroke patients admitted in Rafsan Neuro Rehabilitaion Centre, Peshawar at the time of our study. Duration of the study was kept six months. In this duration the study was completed from data collection till the write up process. Stroke patients of all age groups, both the genders (male and female) and all the stroke patients who were admitted in Rafsan Neuro Rehab Center at time of our study will be included in our study. While patients with congenital upper extremity disorder or amputation, spinal cord injuries and patients who were unable to participate in a rehab program due to any serious comorbidity or cognitive impairments were excluded from the study. Our Null hypothesis was that CPT and VG had equal effects in upper limb stroke rehabilitation. While the Alternate hypothesis was that the VG is more effective than CPT in upper limb stroke rehabilitation. Study proposal was approved from Institutional Ethical Committee and Advanced Studies and Research Board. After approval participants were selected from the study settings and written informed consent was obtained after explaining study purpose and procedure.

The Barthel Index scoring scale was filled after assessing the patients. We provided our treatment protocol to the physical therapy and rehabilitation staff of Rafsan Neuro Rehab Center to implement the protocol for both the groups for four weeks. Each week there was one treatment session of half hour for both the groups. After that we obtained the post-trial findings of both groups through Barthel Index scoring scale. The total value of this scale is 100 in which, 0-20 indicates Total Dependency, 21-60 (Severe Dependency), 61-90 (Moderate Dependency) and 91-99 indicates Slight Dependency. The more the score of the scale, the good is the activity level of patient.

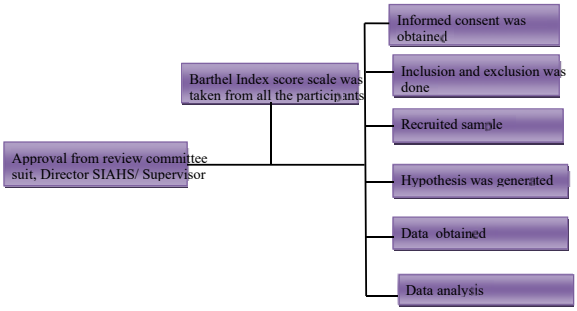

Fig. 1: Flow Chart

Fig. 2: Head Mounted Device

Fig. 3: VR Glasses

Fig. 4: XBOX

Data was scrutinized using SPSS version 20. General characteristics of the subjects were measured using frequencies, mean, percentages, demographic data and standard deviation. Paired T test was used to find effectiveness between VG and CPT. The significance level was set at p=0.05.

RESULTS AND DISCUSSIONS

Sample Characteristics: A total of 18 participants were included in study which were randomonly allocated into two equal groups (CPT and VG). In CPT group the male participants were 7 (87.5%) and female participant was 1 (12.5%), the mean age was 55.13, minimum age was 27 and the maximum age was 73 . In VG group male participants were 6 (75%) and female participants were 2 (25%), the mean age were 66.13, minimum age was 55 and maximum age was 75.

Paired T Test for Pre and Post Activity in CPT Group: Paired T test was applied for pre and post conventional physical therapy assessment in stroke patients rehabilitation, which showed that the P value was 0.214 which was greater than 0.05 and showed that there was no significant changes noted and the null hypothesis was failed to reject.

Paired T Test for Pre and Post Activity in VG Group: T test was applied for the pre and post video gaming assesment in stroke patient's rehabilitation, which showed that the P value was 0.003 that was less than 0.05 and showed significant changes in post video gaming activity so the null hypothesis was rejected. This was an RCT study conducted at Rafsan Neuro Rehab centre that investigated the effectiveness of video gaming and conventional physical therapy technique on upper limb rehabilitation of stroke patients including a total of 18 participants which were randomly allocated into two groups video gaming group and conventional physical therapy group. However our study was mostly related with upper limb rehabilitation other than studying the effect anywhere anatomically, radiologically, or physiologically excluding all incidents of SCIs, RTAs, and type of stroke, side of body affected (i.e. monoplegia, quadriplegia, paraplegia or hemiplegia) . The results were concluded after a 4-week long period in which assessment was done both at the start of admission of a patient and at the time of the discharge of patient after a 4-week stay at the rehabilitation center. Both the groups received the treatment session of half hour every week for 4 weeks. VG technique significantly improving upper limb motor functions, ADLs and early recovery and was best treatment technique than CPT technique. The results demonstrated that the video gaming group achieved significant improvements in Barthel Index scores, indicating better functional recovery compared to the conventional therapy group. The paired T-test confirmed these findings, showing a higher recovery rate for the video gaming group in feeding, bathing, grooming, dressing, bowels, bladder, toilet use, transfers mobility and stairs. The study by[6] investigates the customization and usability of an exergame designed for stroke survivors, focusing on its potential as a tool in physical therapy and rehabilitation. The research employed a play test methodology where stroke survivors engaged with preliminary versions of the exergame over four sessions. This iterative process allowed participants to provide valuable feedback on various aspects of the game, such as its content and mechanics. The insights gained from these sessions were crucial in refining the game to better meet the needs of its users,

Table 1: Baseline Characteristics

CPT	Total 18
Gender	Male 7 (87.5%)
	Female 1 (12.5%)
Age	Mean 55
	Mini 27
	Max 73
VG	Total 18
Gender	Male 6 (75%)
	Female 2 (25%)
Age	Mean 66
	Mini 55
	Max 75

Table 2: Paired T test for Pre and Post Activity in Conventional Physical Therapy Group

	Paired differences Mean	Std. Error	95% Interval of Difference Lower	Confidence of the Upper	T	Df	Sig(2) Tailed
Pre Activity Conventional Physical Therapy-Post Activity Pair 1 Conventinal Physical Therapy	-5.00000	10.35098	3.65963	-13.65364	3.65364	7	.214

Table 3: Paired T test for Pre and Post Activity in Video Gaming Group

	Paired Differences Mean	Std. Deviation	Std. Error	95% Interval of the Difference Lower	Confidence Upper	T	Df	Sig. (2-tailed)
Pre Activity Video Gaming Pair Post Activity 1 Video Gaming	- 22.50000	13.88730	4.90990	-34.11007	-10.88993	-4.583	7	.003

demonstrating the iterative nature of game development in therapeutic settings. In addition to the play test sessions, a pilot study was conducted with 10 stroke survivors to evaluate the exergame's effectiveness. This study assessed several key factors including game mechanics, the level of assistance provided, user experience, motion sickness, and immersion. The results from this pilot study indicated that the exergame was well-received by participants, with significant improvements made based on their feedback. The exergame specifically targets essential shoulder and elbow movements, which are crucial for upper limb rehabilitation in stroke survivors, enhancing its relevance and utility in therapy. Overall, the research highlights the iterative approach to game design as a critical component in developing effective rehabilitation tools. The positive feedback from participants and the improvements made to the exergames underscore its potential as a valuable adjunct to traditional therapeutic methods. The study suggests that integrating exergames into physical therapy can enhance rehabilitation outcomes and user satisfaction, paving the way for more personalized and engaging therapeutic interventions for stroke survivors.

A study conducted in Luxembourg investigated the effectiveness of immersive virtual reality (VR) therapy for stroke rehabilitation. The researchers analyzed 10 controlled trials involving 324 participants and found that VR therapy significantly outperformed traditional rehabilitation methods in improving upper limb function, activities of daily living, and reducing pain. These findings highlighted the potential of VR as a valuable tool for stroke patients. The study done by Nathalie Godart[7] revealed that immersive VR therapy can effectively enhance upper limb function, improve daily living activities and alleviate pain in stroke survivors. These positive outcomes suggest that VR offers a promising approach to stroke rehabilitation, potentially improving the quality of life for patients. A study investigated the impact of incorporating interactive video games into traditional rehabilitation programs for individuals with hemiplegic stroke. Eighteen stroke patients were divided into two groups: one received only conventional rehabilitation (the control group), while the other received conventional rehabilitation combined with interactive video gaming (the intervention group). The research aimed to assess changes in radiological markers, using diffusion tensor imaging and improvements in upper limb functional abilities. Evaluations were conducted at the beginning of the study and after a four-week rehabilitation period. The findings revealed that the control group showed some improvements in certain radiological measures, indicating partial progress in brain structure related to stroke recovery. However, the intervention group, which engaged in interactive video gaming alongside conventional therapy, did not show

significant changes in radiological outcomes. Despite this, both groups exhibited similar levels of improvement in upper limb motor function and self-care abilities, with no significant difference between the two groups. While no changes were detected in radiological status in the intervention group ($p>0.05$), some regions on the affected side were improved significantly in the control group ($p<0.05$). Total upper extremity motor functioning part of the Fugl Meyer Assessment scores and the self-care part of the FIM scores significantly improved in both groups ($p<0.05$). No differences were detected in the amount of changes between groups ($p>0.05$). The study concluded that adding interactive video games to conventional rehabilitation programs did not provide additional benefits in terms of radiological progression or upper limb functional status. This suggests that while video gaming can be an engaging addition to rehabilitation, it may not offer substantial advantages over traditional methods in these specific measures of stroke recovery[7,8].

CONCLUSION

In this study it was concluded that video gaming was more effective than conventional physical therapy in upper limb stroke rehabilitation. Video Gaming group showed significant improvement and good prognosis in comparison to the conventional physical therapy group in most of the variables of the Barthel Index.

Limitations: Our Sample size was small which limits generalizability of the results. Due to limited time, we only provided 4-weeks for rehabilitation which may not capture long term effects. It was a single centre study which limited the diversity of patient population. Another constraint was limited resources and lower budget of the study.

Recommendations: Future researchers should conduct such studies on larger populations and on multiple rehabilitation setups. Long-term follow-ups should be implemented to assess the sustainability of benefits. Advance VR gadgets and established setups should be used for further elaborative outcomes. Future rehabilitation specialists should incorporate VR technique in their contemporary practice for early and effective upper limb stroke rehabilitation.

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