Effect of Virtual Reality Therapy for the Enhancement of Upper Limb Functions in Patients with Stroke

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ABSTRACT:

BACKGROUND: Stroke, a prevalent cause of disability and mortality globally, presents significant challenges to healthcare systems, especially in emerging nations.Innovations like virtual reality (VR) technology offer promising solutions in stroke rehabilitation. This study delves into VR'srole in stroke rehabilitation, synthesizing evidence to assess its impact on motor function and therapy outcomes, aiming to guide clinical practice and future research directions.

OBJECTIVE: To find the effectiveness of virtual reality therapy for the enhancement of upper limb functions after stroke

METHODS: 30 Participants with Middle Cerebral Artery stroke who met the requirements was enrolled in the study with permission from their caregiver or legal guardian. The upper limb motor assessment scale was used to gather the samples. A record of the pre-test value wasmade.

STUDY GROUP: The participants received 30 minutes of virtual reality therapy in a day for 3 sessions a week for 4 weeks. In order to improve upper limb functions, the intervention was monitored using motor assessment scale for upper extremities functions. The post-test results were given,and the scores were reevaluated.

RESULT: Result shows that there is a significant improvement in upper limb functions by using the virtual reality therapy. Therefore, statistical analysis indicated a statistically significant difference (p value <0.0001) in pre and post-test.

CONCLUSION: From the result obtained from the study, it can be concluded that virtual reality therapy shows significant effect on improving upper limb functions in patients with stroke.

KEY WORDS: virtual reality, stroke, upper limb enhancement.

INTRODUCTION

Stroke, a significant cause of disability and mortality globally, poses a growing challenge, particularly in emerging nations [(1)]. With its debilitating effects, stroke, often termed a "brainattack," results from ischemia or hemorrhage, causing sudden paralysis, speech impairment, or vision loss [(2)]. Factors like reduced activity, dyslipidemia, and hypertension elevate strokerisk, especially in populations over 40, as observed in southwest China [(3)]. Subtypes include cardioembolic, big artery disease, small artery disease, and undetermined, with cerebral hemorrhage and ischemic strokes being predominant [(4)].

Virtual Reality (VR) technology offers an immersive, interactive interface, replicating realistic environments [(5)]. Widely accepted in entertainment and gaming, VR's potential extends to rehabilitation, where it enhances communication,

decision-making, and therapy outcomes [6, 7]. Stroke diagnosis relies on urgent brain imaging, crucial for hyperacute therapyselection, impacting secondary prevention [8].

Innovative approaches like VR-based rehabilitation have gained traction, leveraging VR's ability to provide sensory input, immersive environments, and real-time feedback for motor learning and neuroplasticity [9]. VR has shown promise in reducing acute and chronic pain through mechanisms like neuromodulation and distraction [10]. Its potential extends to enhancing exercise performance and motor function in stroke patients, backed by numerous meta-analyses and experimental studies [11].

Upper-limb dysfunction is common among stroke survivors, impairing daily activities and quality of life [12]. As the elderly stroke population grows, early identification and therapy arecrucial for optimal outcomes, with technology-driven interventions offering potential benefits[13]. VR systems, ranging from immersive headsets to interface devices, enable task-specific training and cognitive engagement, enhancing motor recovery [14, 15].

The gap between stroke survivors' actual and ideal worlds can be bridged by VR-based proprioception feedback training, improving motor control [16]. Task-oriented, repetitive training with VR gaming systems promotes cortical reconfiguration, enhancing motor recovery, especially with extended therapy duration [17].

The rise of VR-based rehabilitation systems stems from their user-friendliness, adaptability, and capacity for individualized training, leading to increased therapy efficacy and patient engagement [18]. Stroke-related impairments like aberrant muscle tone and loss of dexterity vary in severity and necessitate precise clinical evaluation for tailored interventions [19].

Virtual rehabilitation utilizes visual, auditory, tactile, and proprioceptive feedback to simulatereal-world scenarios, aiding behavior modification and problem-solving [20]. VR therapy findsapplications in cognitive and behavioral skills training, as well as exposure-based therapy [21].

Stroke poses a significant global health burden, necessitating innovative approaches like VR-based rehabilitation to improve outcomes. The immersive nature of VR technology offers promising avenues for enhancing motor function, cognitive skills, and overall quality of life for stroke survivors. As research in this field continues to evolve, VR holds immense potentialto revolutionize stroke rehabilitation practices and improve patient outcomes worldwide. In this context, this study aims to find the effectiveness of virtual reality therapy for the enhancement of upper limb function in patients with stroke.

METHODS:

The study used a quasi-experimental design and focused on stroke survivors who had experienced middle cerebral artery (MCA) infarctions. A convenient sampling approach was used to obtain a sample size of 30 people. Individuals aged 30 to 60, both male and female, who had suffered middle cerebral artery strokes were chosen. Patients who had musculoskeletal issues, cardiovascular diseases, or motion sickness were excluded.

The study procedure involved selecting thirty stroke patients from a private medical college hospital at Chennai. Prior to therapy, participants received comprehensive education about the study and provided formal informed consent. Convenient sampling was employed for participant selection. A virtual reality headgear capable of altering phone display and a gyroscope for 360-degree engagement were utilized. Therapy sessions lasted 30 minutes eachwith short rest intervals in a day for 3 sessions a week for 4 weeks. Baseline assessments of upper limb function were conducted using the motor assessment scale. Virtual reality trainingcomprised activities like boxing, object retrieval, and space war to engage participants in upper limb movements. Progress and adherence to the intervention were monitored throughout sessions. Post-therapy the post-test data was noted and results were analyzed. Initial screenings included CT scans, blood tests, and neurological examinations to confirm stroke presence and severity.

RESULT:

The post-assessment demonstrates a noteworthy improvement in upper limb capabilities through the use of virtual reality therapy when compared to the pre-assessment. Pre-test and post-test results showed a statistically significant difference, according to statistical analysis.Table 1 consists of demographic data of population.

DISCUSSION:

This study addressing the effectiveness of virtual reality therapy for the enhancement of upperlimb functions in patients with stroke. This research highlighted virtual reality therapy for theenhancement of the functions of upper extremities. Shamekh El-Shamy et al., 2017 concluded that the virtual reality program proves notably superior to traditional physiotherapy methods in enhancing upper extremity functions among children. This innovative approach demonstrates considerable efficacy in promoting rehabilitation outcomes compared to conventional techniques. Its immersive nature engages children more deeply, leading to heightened motivation and participation in therapeutic exercises. Virtual reality therapy offersa promising avenue for maximizing therapeutic benefits and improving the overall quality ofcare for children undergoing rehabilitation for upper extremity impairments [8]. Ehab Mohamed Abd El-Kafy et al.,2021 concluded that utilizing both virtual reality-based therapyand conventional physiotherapy concurrently yields superior outcomes in enhancing upper limb functions among chronic stroke patients compared to solely employing conventional physiotherapy. The combined treatment approach offers a more effective intervention strategy,leveraging the immersive engagement of virtual reality alongside traditional physical rehabilitation methods. This integrated approach demonstrates promising results in addressingthe rehabilitation needs of individuals with chronic stroke, potentially enhancing overall functional recovery and quality of life [11]. Jinlong Wu et al., 2021 concluded that the virtual reality (VR) shows promise in enhancing motor abilities among stroke patients, particularly in upper limb function and balance, with a notable medium to large effect size. However, theabsence of a tailored rehabilitation protocol can be attributed to the variability in motor capabilities among patients. Therefore, further investigation necessitates randomized controlled trials encompassing larger cohorts and extended durations. These trials aim to ascertain whether VR-based interventions stand as the superior approach for ameliorating motor performance in stroke survivors. Additionally, they seek to determine the optimal parameters for VR training, including type, frequency, duration, and progression, tailored to accommodate the diverse spectrum of motor abilities observed among stroke patients. This comprehensive exploration is pivotal for optimizing the efficacy of VR interventions in strokerehabilitation [12]. Ja Young Choi et al., [2020] concluded that The utilization of virtual realitytraining has demonstrated superior effectiveness compared to traditional occupational therapyin enhancing dexterity, performing daily activities, and promoting active forearm supination motion among children with chronic brain injury, particularly those facing severe motor impairments. This pioneering therapeutic method employing virtual reality stands to serve as

a valuable adjunct to conventional rehabilitation practices by instilling motivation andbolstering motor skill acquisition in this pediatric population [13]. Tereza Gueye et al., 2021 concluded that incorporating virtual reality therapy (VRT) with visual biofeedback into earlypost-stroke rehabilitation alongside standard daily programs proves more beneficial for upper extremity motor recovery compared to traditional physiotherapy methods. Notably, this enhanced approach maintains its effectiveness across age groups, suggesting its potential as a valuable supplement to conventional physiotherapy for both older and younger stroke patients [14]. Corina Schuster-Amft et al., 2018 concluded that A specialized virtual reality training system tailored for individuals with sensorimotor impairments offers three distinct display modes for hand and arm movements, providing a secure training avenue. Comparative analysis between virtual reality-based training and traditional physiotherapy and occupationaltherapy, conducted through supervised one-on-one sessions, revealed no significant disparities. Despite variations in therapy focus, both approaches demonstrated efficacy. Withthe anticipated rise in post-stroke patient numbers and constraints on staffing and finances, integrating virtual reality-based training could enhance rehabilitation efforts. This integration could extend training durations by incorporating virtual reality group sessions within inpatient or outpatient facilities, or even within patients' homes. Consequently, virtual reality-based training has the potential to augment rehabilitation efforts and accommodate the growing demand for stroke rehabilitation within resource-constrained environments [19].

The study findings suggest that virtual reality therapy demonstrates significant efficacy in enhancing upper limb functions among stroke patients. Through rigorous analysis of pre-testand post-test data, It is clear that virtual reality interventions have the potential to be a valuabletool in stroke rehabilitation. These results underscore the potential of innovative technologieslike virtual reality to positively impact motor recovery and functional outcomes in individuals recovering from stroke-related impairments.

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21. Emmelkamp PM, Meyerbröker K. Virtual reality therapy in mental health. Annual review of clinical psychology. 2021 May 7;17:495-51STATISTICAL ANALYSIS:

WILCOXON TEST: Pre-test and post-test values for virtual reality therapy in patients with stroke using motor assessment scale (TABLE 2).

TABLE 1: DEMOGRAPHIC DATA

NUMBER OF PATIENTS WITH STROKE	**AGE**			**MALE**	**FEMALE**	**BMI (BODY MASS INDEX)**		
	30-40	40-50	50-60			<18.5	18.5-24.9	25.0-29.9
30	8	11	11	18	12	1	25	4

The pre-test result was 2.00 before receiving virtual reality therapy, and it dramatically increased to 5.07 in the post-test. For this shift, W value is 0. Considering that the p-value is less than 0.0001, the observed statistical significance is remarkable. This suggests a statistically significant variation in the outcomes, so validating the efficacy of virtual reality treatment in improving upper limb capabilities among stroke patients.

TABLE 2: STATISTICS

GROUP	**MAS**	**MEAN**	**SD**	**W- VALUE**	**P-VALUE**
VIRTUAL REALITY	PRE-TEST	2.00	0.79	0	<0.0001
	POST-TEST	5.07	0.98		