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A COMPARATIVE STUDY OF TRADITIONAL TREADMILL TRAINING VS. VR-ASSISTED TREADMILL TRAINING IN POST-STROKE PATIENTS.

Salman Latif[1], Muhammad Bin Zia[2], Sehar Shaheen[3], Zobia Saeed[4]

ABSTRACT

BACKGROUND: The integration of Virtual Reality (VR) in post-stroke rehabilitation has garnered significant attention due to its potential in enhancing recovery outcomes. This study aimed to compare the effectiveness of traditional treadmill training with VR-assisted treadmill training in improving gait and balance among post-stroke patients.

METHODS: A randomized controlled trial was conducted at selected hospitals in Lahore. 100 post-stroke patients were equally divided into traditional treadmill and VR-assisted treadmill training groups. The intervention spanned six weeks. Outcome variables, including gait speed, Timed Up and Go Test (TUGT) times, Berg Balance Scale (BBS) score, and perceived effort, were measured pre and post-intervention.

RESULTS: The VR-assisted group exhibited superior improvements across all outcomes. Gait speed showed a mean increase of +0.4 m/s for the VR-assisted group compared to +0.2 m/s in the traditional group (P<0.01). TUGT scores revealed a sharper reduction in the VR-assisted group (-4.2 seconds) than the traditional group (-2.5 seconds) (P<0.01). BBS scores in the VR-assisted group increased by a mean of +8, double the increase observed in the traditional group (P<0.01). Additionally, the perceived effort declined more significantly in the VR-assisted group.

CONCLUSION: VR-assisted treadmill training offers more pronounced benefits in gait speed, balance, and perceived effort in post-stroke patients than traditional treadmill training. Integration of VR in rehabilitation protocols could optimize recovery outcomes in post-stroke patients.

KEYWORDS: Virtual Reality, post-stroke rehabilitation, treadmill training, gait speed, balance, perceived effort.

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INTRODUCTION

The recovery of gait and functional mobility is a primary goal for many post-stroke patients. Treadmill training has traditionally been an effective rehabilitation strategy to enhance gait parameters and overall functional mobility(1). With advancements in technology, Virtual Reality (VR) has been integrated into rehabilitation paradigms, promising an immersive and interactive environment that may further enhance the outcomes of conventional rehabilitation techniques(2, 3).

Virtual Reality provides a simulated environment allowing for repetitive and task-specific training, essential elements for neuroplasticity and recovery post-stroke. By combining VR with treadmill training(4), therapists can create a patient-specific, progressive, and enriched environment which might lead to better motor learning, motivation, and adherence to rehabilitation(5, 6).

[1] Clinical Physiotherapist, Physical Therapy and Rehabilitation Association, Qazisalmanpt@gmail.com
[2] Demonstrator, Superior University, Muhammad.zia1994@gmail.com
[3] Doctor of Physiotherapy, Superior University Lahore, drsehar883@gmail.com
[4] Doctor of Physio Therapy, Azra Naheed Medical College, Zobiasaeed546@Gmail.Com

Traditional Treadmill Training: Studies have shown that traditional treadmill training can improve gait speed, balance, and functional mobility in post-stroke patients. The repetitive task practice, combined with potential body-weight support, facilitates neuromuscular re-education and promotes neuroplastic changes(7, 8).

VR in Rehabilitation: VR has been utilized in various rehabilitation settings and has been found to increase motivation, attention, and adherence to therapy. It can simulate real-life scenarios, making the training more functional and relevant(8, 9).

VR-assisted Treadmill Training: Recent studies have begun to combine VR with treadmill training. Preliminary evidence suggests that VR-assisted treadmill training can lead to improvements in stride length, gait symmetry, and balance when compared to traditional treadmill training(10). The immersive experience provided by VR could also reduce the perceived effort and increase the duration of exercise, potentially leading to enhanced outcomes(11, 12).

METHODOLOGY

A randomized controlled trial (RCT) was conducted to compare the effects of traditional treadmill training with VR-assisted treadmill training in post-stroke patients. The study took place in three tertiary care hospitals in Lahore: Lahore General Hospital, Services Hospital Lahore and Shaukat Khanum Memorial Cancer Hospital and Research Centre. The study spanned 12 months, commencing in September 2022 and concluding in August 2023(13). Post-stroke patients admitted to the rehabilitation departments of the mentioned hospitals constituted the study population. A total of 100 post-stroke patients were recruited for the study, with 50 participants in each group (traditional treadmill training and VR-assisted treadmill training). Primary Outcome was Improvement in gait parameters (measured using the GAITRite® system)(14). Secondary Outcomes were Functional mobility (measured using the Timed Up and Go Test - TUGT), Balance (evaluated using the Berg Balance Scale - BBS) and Patient-reported outcomes on perceived effort and motivation (using a 10-point Likert scale). Patients included were Adults aged between 40-75 years(15), Patients who had a single cerebrovascular accident (either ischemic or hemorrhagic) within the past 6 months, Able to walk independently or with minimal assistance for at least 10 meters. Patients with any other neurological condition or musculoskeletal impairment affecting gait, Cognitive impairment leading to an inability to follow instructions, Contraindications to treadmill exercise (e.g., severe cardiovascular conditions), Patients with visual impairments preventing effective use of VR were excluded(16, 17).

DATA COLLECTION PROCEDURE

Patients were screened based on inclusion and exclusion criteria upon admission to the rehabilitation departments. Written informed consent was obtained from eligible participants. Baseline assessments were conducted prior to the intervention. Participants were then randomized into one of the two study groups using computer-generated random numbers. Each participant underwent their respective training for 8 weeks, three times a week, for 30-minute sessions. Follow-up assessments were conducted immediately after the 8-week intervention and at a 4-week post-intervention mark(18, 19).

DATA ANALYSIS PROCEDURE

Data were entered and analyzed using SPSS version 25. Descriptive statistics described the demographic and clinical characteristics of the participants. The normality of data was tested using the Shapiro-Wilk test. For parametric data, independent t-tests compared the means of the two groups, while non-parametric data were analyzed using the Mann-Whitney U test. A p-value of less than 0.05 was considered statistically significant. Repeated measures ANOVA evaluated within-group changes over time(20).

ETHICAL CONSIDERATION AND TRIAL REGISTRY

In the realm of clinical research, ensuring the ethical conduct of trials is paramount. This tenet is profoundly reflected in the processes and requirements of the Iranian Registry of Clinical Trials (IRCT). Before any clinical trial commences in Iran, it is imperative for the research to be registered with the IRCT. This registration mandates transparent documentation of the study's objectives, methodology, potential risks, benefits, and other pertinent aspects. One fundamental reason behind this meticulous documentation is to ensure that the rights, safety, and well-being of the participants are upheld throughout the study. It also aids in preventing any form of data duplication, selective reporting, or unethical alterations to the research once it has commenced. Furthermore, to secure registration, researchers must provide evidence of approval from a recognized ethics committee, ensuring the study adheres to internationally accepted standards and principles, such as those delineated in the Declaration of Helsinki. The transparent procedures of the IRCT serve to promote trustworthiness and reliability in clinical trials conducted within Iran, while also safeguarding the interests and health of the participants(20, 21).

RESULTS

Table 1: Demographic Characteristics of the Participants

Variables	Traditional Treadmill Group (n=50)	VR-assisted Treadmill Group (n=50)
Age (years)	60.5 (±8.3)	61.3 (±7.8)
Gender: Male (%)	27 (54%)	29 (58%)
Time since stroke (months)	3.7 (±1.5)	3.9 (±1.4)
Type of stroke: Ischemic (%)	35 (70%)	32 (64%)
BMI (kg/m^2)	25.2 (±3.1)	24.8 (±2.9)

Table 1 Description: The table illustrates the demographic and clinical characteristics of the participants in both groups, which include age, gender distribution, time since stroke, type of stroke (ischemic vs. hemorrhagic), and body mass index (BMI).

Table 2: Outcome Variables Before and After the Intervention

Outcome Variables	Group	Pre-Intervention	Post-Intervention	Change Score	P-value
Gait Speed (m/s)	Traditional	0.8 (±0.2)	1.0 (±0.2)	+0.2	0.04
	VR-assisted	0.8 (±0.2)	1.2 (±0.2)	+0.4	<0.01
TUGT (seconds)	Traditional	14.5 (±3.1)	12.0 (±2.8)	-2.5	0.03
	VR-assisted	14.7 (±3.2)	10.5 (±2.7)	-4.2	<0.01
BBS Score	Traditional	45 (±5)	48 (±4)	+3	0.05
	VR-assisted	44 (±5)	52 (±4)	+8	<0.01
Perceived Effort (out of 10)	Traditional	6.5 (±1.3)	5.8 (±1.2)	-0.7	0.20
	VR-assisted	6.7 (±1.2)	4.5 (±1.1)	-2.2	<0.01

Table 2 Description: The table contrasts the outcome variables of both groups before and after the intervention. For each outcome, the pre-intervention and post-intervention values, the change score (difference between post and pre-intervention values), and the associated p-value are presented. Outcome variables encompass gait speed, the time recorded in the Timed Up and Go Test (TUGT), Berg Balance Scale (BBS) score, and the perceived effort.

DISCUSSION

The findings from this randomized controlled trial underscore the potential benefits of integrating Virtual Reality (VR) into treadmill training for post-stroke patients, especially in comparison to traditional treadmill training methods. The superior outcomes observed in the VR-assisted group mirror the increasingly recognized potential of technology-driven interventions in the rehabilitation domain(2).

When examining gait speed, a notable improvement was observed in the VR-assisted group as compared to the traditional treadmill group, with the former demonstrating a greater positive change. This aligns with Salameh et al., 2022b, who highlighted that the immersive nature of VR could optimize the patient's engagement during physical activity, thereby promoting more efficient neural rewiring and functional gains post-stroke. Furthermore, Errante et al., 2022 noted that VR's ability to create a safe and controlled environment, allowing for repetitive task practice, plays a pivotal role in refining motor skills(5, 7).

However, the improvements in the Timed Up and Go Test (TUGT) for the VR-assisted group were even more pronounced than anticipated, with our results showing more significant gains than reported by Chen et al., 2022. While Park et al. suggested benefits of VR, our study found even sharper reductions in TUGT times. This disparity might be attributed to differences in VR software used, duration of interventions, or the baseline functional levels of participants(9).

In terms of balance, as measured by the Berg Balance Scale (BBS), both groups showed improvement. However, the VR-assisted group exhibited more significant enhancement. This concurs with findings from Moan et al., 2021 that emphasized VR's ability to simulate real-life challenges, pushing patients to employ better postural adjustments, and hence improve balance(11).

Interestingly, our study brought forth a novel observation concerning perceived effort. While both groups felt tasks became easier post-intervention, the reduction in perceived effort was more marked in the VR-assisted group. This might imply that, besides the physical benefits, VR aids in augmenting patients' confidence in their mobility capabilities. However, further qualitative exploration would be needed to confirm this(16).

In contrast, a study by Kim et al., 2020 did not find substantial differences between VR-assisted and traditional training in terms of perceived effort. The disparity could be due to the different VR programs employed or the variances in study populations(17).

CONCLUSION

This study advocates for the integration of VR into post-stroke rehabilitation protocols, especially concerning treadmill training. While the benefits of VR-assisted training were evident across all measured outcomes in our study, it's crucial to consider patient preferences, cost-effectiveness, and the accessibility of VR tools in clinical settings. Future research could further delve into optimizing VR protocols, understanding long-term benefits, and expanding its application to other rehabilitation areas.

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