Virtual reality training improves turning capacity and functional reach in stroke patients

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Objective: To determine the added effects of virtual reality training on turning capacity, gait parameters and functional reach capacity of stroke patients compared to task oriented training alone.

Methodology: A randomized control trial was conducted from February 2016 to July 2106 at Physical Rehabilitation Department Pakistan Railway Hospital, Rawalpindi, Pakistan. Twenty stroke patients were selected through purposive sampling. The patients were randomly assigned through sealed envelope method into two groups; Task Oriented Training (TOT) and Virtual Reality Training (VRT) Group. The standardized tools were used for assessment. The TOT was provided for 4 days per week for 6 weeks while VRT group received additional exer-gaming training during sessions.

Results: Significant improvement was observed in both groups regarding reaching forward, turning 360, gait pivot turn (p ? 0.01) and FRT (p ? 0.001). The two groups were statistically different from each other in terms of turning capacity, reaching forward, gait pivot turn and functional reach after 6 weeks of intervention (p ? 0.05)

Conclusion: Addition of virtual reality training further improves the significant improvement caused by task oriented training on turning capacity, reaching forward, gait pivot turn and functional reach in stroke patients. (Rawal Med J 201;42:158-161)

Key words: Functional reach, stroke, turning capacity, virtual reality training.

INTRODUCTION

Stroke is one of the most disabling conditions in the world.[1] Stroke survivors have an increased risk for falls and subsequent injuries due to their locomotor disabilities, including impaired balance, decreased stride length, decreased walking speed and compromised ability to step over objects.[2,3] Particularly a reduced ability to balance properly due to increase in postural sway, asymmetrical weight distribution, loss of weight shift causing increase risk of fall and results in significant social burden.[4,5]

Traditional balancing techniques rely on repetitions of specific movements, which patient may find aimless and boring resulting in reduced motivation.[6,7] Turning capacity is compromised as exemplified by the greater number of steps and time required to complete turns at each angle tested. Turning capacity is related to the degree of gait asymmetry and level of functional ambulation.[8] Turning requires the central nervous system to coordinate whole body re-orientation towards a new direction.[9] Recent studies suggest that stroke patients turn more slowly because of the absence of kinematic and muscular modulations in the affected leg.[10]

Recently, the implementation of virtual technology in stroke rehabilitation has attracted massive attention globally.[11] Virtual reality (VR) involves computer generated interactive stimulation that controls the information delivered to sensory organs to provide a virtual environment and makes the participant think that imaginary objects and incidents are real.[12] The virtual reality technology is used to enhance the quality of life in the field of neuromuscular rehabilitation by improving physical function of stroke patients.[13,14] Virtual reality training (VRT) may help by facilitating several neural many neural patterns of brain, and many studies are in process to check the effect of VR on postural control. Virtual reality has an augmented effect to improve balance and mobility.[15] The objective of current study was to compare the added effect of VRT and task oriented training (TOT) alone on reaching forward, turning and gait pivot capacity and functional reach of stroke patients.

METHODOLOGY

This randomized control trial was conducted from February 2016 to July 2106 in Physical Rehabilitation Department Pakistan Railway Hospital Rawalpindi, Pakistan and included 20 stroke patients selected through purposive sampling. Patients with any stroke type, age bracket 40-60 year, able to stand and 2-4 on Modified Rankin disability scale were included while patients with cognitive and visual impairments were excluded.

The patients were randomly assigned through sealed envelope method into two groups; TOT and VRT. The basic demographics were noted and standardized tools were used for assessment. These included reaching forward, turning 360, gait pivot turn and Functional Reach Test (FRT). The additional virtual reality training was provided to VRT group while TOT group only underwent task oriented training alone for 4 days per week for 6 weeks.

The TOT group was assigned to do different balance training activities including stepping, tandem walking, reaching activities, standing balance on different surfaces, marked gait training, sit to stand practice. The VRT group was provided additional 15 minutes of Xbox Exer-gaming**.** The virtual reality protocol included 4 games (20,000 Water leaks, River rush & Reflex ridge). The first day was orientation day in which researcher completely explained the purpose of game and how to play the game. During the 1st & 2nd week the subjects practiced water leaks in which they tried to stop water leakage through body movements. In 3rd week they practiced the river rush in which they have to cross river and avoid hurdles. The reflex ridge game was practiced in 4th week and subjects were moving while avoiding obstacles. During the 5th & 6th week the combinations of games were practiced to achieve maximum outcome.

RESULTS

The mean age of the participants was 50.0±9.07 in VRT group and 50.16±86 in TOT group. 70% were male while 30% were female. Within the VRT group, significant improvements were observed in reaching forward score (*p* ? 0.01), turning 360° (*p* ? 0.01), and gait pivot turn (*p* ? 0.01) (Table 1). Similarly, the patients in TOT group improved significantly with respect to reaching forward score (*p* ? 0.01), turning 360° (*p* ? 0.01), and gait pivot turn (*p* ? 0.01) (Table 1).

Table 1. Pre and post difference within groups.*

Variable	Pre Median	Post Median	P value
	VRT group		
Reaching forward	2	4	0.004**
Turning 360	1	4	0.004**
Gait pivot turn	0	3	0.003**
	TOT group		
Reaching forward	2	3	0.003**
Turning 360	2	3	0.003**
Gait pivot turn	0	2	0.002**

*Wilcoxin Test **significant change ($p \leq 0.01$)

Table 2. Comparison of reaching forward Score between VRT & TOT groups.*

Variable	Median	Mean rank	Sum of rank	*P*-value
At Baseline: VRT Group	1	10.50	126	
TOT Group	2	14.50	174	0.178
After 02 wk: VRT Group	2	9.92	119	
TOT Group	2	15.08	181	0.078
After 04 wk: VRT Group	3	9.41	103.50	
TOT Group	3	12.75	127.50	0.223
After 06 wk: VRT Group	4	14.45	144.50	
TOT Group	3	7.86	86.50	0.013*

*Mann–Whitney U test

Table 3. Comparison of Turning 360 Score between VRT & TOT groups.*

Variable	Median	Mean rank	Sum of rank	*P*-value
At Baseline: VRT Group	1	11	132	
TOT Group	2	14	168	0.319
After 02 wk: VRT Group	2	12.0	150	
TOT Group	2	12.50	150	1
After 04 wk: VRT Group	3	11.23	123.50	
TOT Group	2.5	10.75	107.50	0.863
After 06 wk: VRT Group	4	14.90	149	
TOT Group	3	7.45	82	0.005**

*Mann–Whitney U test

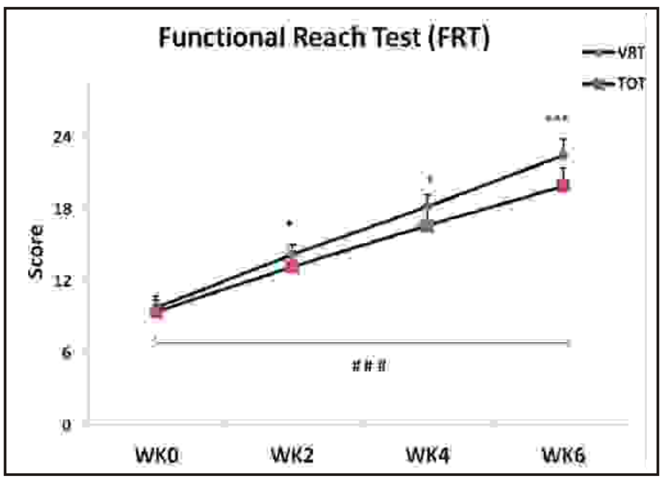
Table 4. Comparison of Gait Pivot turn Score between VRT & TOT groups.*

Variable		Median	Mean rank	Sum of rank	*P*-value
At Baseline:	VRT Group	0	12.50	150	
	TOT Group	0	12.50	150	1
After 02 wk:	VRT Group	1	12.50	150	
	TOT Group	1	12.50	150	1
After 04 wk:	VRT Group	2	12.59	138.50	
	TOT Group	1.5	9.25	92.50	0.223
After 06 wk:	VRT Group	3	13.90	139	
	TOT Group	2	8.36	92	0.043*

*Mann–Whitney U test

Although both groups were similar on all counts at the baseline (*p* ? 0.05), there was statistically significant difference present between the groups after 6 weeks in terms of reaching forward score (*p* ? 0.05) (Table 2), turning 360° (*p* ? 0.01) (Table 3), and gait pivot turn (*p* ? 0.05) (Table 4).

Fig. 1. Week wise comparison of Functional Reach Test in VRT & TOT groups.



Similarly, the groups were comparable at the baseline regarding functional reach test score. Significant improvement was noted in both groups after 6 weeks of interventions (*p* ? 0.001). After two weeks of intervention, both groups were already significantly different (*p* ? 0.05) and this difference became more marked at the completion of intervention period (*p* ? 0.001) (Fig. 1).

DISCUSSION

The study finding reports that there is significant improvement in reaching forward performance of patients in virtual reality training group as compared to TOT group after 6 weeks of training. Five week additional VRT had better outcome in improving the postural control and balance as compare to the conventional training.[16,17] In comparison with conventional treatment approach, the VRT is consistent in improving the control of movement and anticipation control.[14] Bission et al. conducted a study on 12 healthy individuals to compare the VRT and biofeedback for 10 weeks of training with 30 minutes session per week and concluded that the both groups showed significant difference in quiet stance, postural sway and reaction time.[13]

The exer-gaming enhances the capacity to turn and pivot around the point and maintains the balance. It prevents the patients from frequent falls.[10] This study suggests that the VRT is also effective in improving the gait parameters, functional reach and pivot turn in stroke patients while there was also significant improvement in TOT group after 6 week of training. The stroke patients get improvement in gait parameter when they perform task in virtual environment and move in multiple directions.[18] A systematic review also supported the findings of study and highlighted that this artificial environment plays important role in improving gait parameters.[19]

The current finding concurs with previous studies, which reported that the VRT is good therapeutic tool to engage the patients in activities and gets the better improvement in context of postural stability.[20, 21] We demonstrated that addition of VRT enhanced the functional recovery in stroke patients, which confirmed the findings of an earlier study.[22]

CONCLUSION

We found that 6 weeks additional virtual reality training significantly further improved the reaching forward, turning, pivot turn capacity and reaching forward in stroke patients as compared to task oriented training alone. Functional reach capacity has quickened and marked improvement after 2 weeks in additional virtual reality training group in stroke patients.

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Conception and design: ANM, TH
Collection and assembly of data: ANM
Analysis and interpretation of the data: TH
Drafting of the article: TH
Critical revision of the article for important intellectual content: TH
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