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Virtual reality Xbox 360 Kinect training for stroke patients with hemiplegia.

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A stroke or cerebrovascular accident (CVA) can be defined as the rapid loss of brain function due to disturbance of the brain blood supply which may be ischemic due to blockage (arterial thrombosis, embolism), or a hemorrhagic. Many patients with stroke have significant motor impairments and disabilities that affect their level of functional independence. Upper limb dysfunction is the most important cause for limitations in the daily activities of post- stroke individuals. The aim of this study was to assess the effects of virtual reality (VR) training program on upper extremity function and activities of daily living (ADL) in chronic stroke patients.

Keywords: Barthl index, Hand dynamometer, Stroke, Virtual reality x box 360 training.

INTRODUCTION

Stroke, tumors and cardiovascular diseases are the three most common causes of death. mortality rate from stroke decrease with modern advanced technology however long term upper extremity disability increases (Aydin et al.,2016). Stroke is a common neurological disorder and a common cause of chronic impairment worldwide (Alexander et al., 2009).It usually causes hemiplegia resulting in motor deficits (Kim and Cha 2011). The impairment of motor skills in stroke patients with hemiplegia is a main cause for hindering the daily living activities (Dijkerman et al., 2004). Eighty-five percent of stroke individuals have upper limb dysfunctions in the acute stage (Ryerson, 2001).

After 3–6 months about 55–75% of post-stroke patients have persistent upper limb dysfunctions (Olsen, 1990). Upper limb dysfunction is the most common cause for limitations in the activities of daily living in post- stroke individuals (Lee et al., 2010). Hemiplegia makes the functional use of the affected upper extremity for performing daily living tasks difficult. As, improvements in the upper limb motor ability of post-stroke patients will enable the patient to be independent in performing the daily living tasks so, the rehabilitation programs should emphasize the improvement of upper limb functions(Park and Park 2016).

The virtual reality training provides auditory, visual, and proprioceptive feedback in a virtual reality environment, providing suitable individualized exercise training programs. Virtual reality training can adjust the training environment by modifying the difficulty of the exercise to be suitable to the patient's level of affection and abilities (Park et al., 2014). VR environments have been used in rehabilitation of stroke patients Langhorne et al., 2011). It has been mainly used as rehabilitating tool for the functional recovery of the upper extremities Yang et al.,2008), and it is effective in achieving recovery of upper extremity function in individuals with stroke (Brunner et al.,2014).

MATERIALS AND METHODS

Sixty stroke patients with mild-to-moderate paresis in the upper extremity between 50 and 70 years of age referred to the outpatient clinic, who were diagnosed with stroke with hemiparesis, were randomized in the study. Patients with surgical interventions in the brain or upper limbs were excluded from the study. Written informed consent was obtained from each patient. Age, sex, duration of disease, and side of affection of the patients were recorded. The study was designed as a prospective randomised clinical trial. Patients were randomized into 2 groups, each group consisting of 30 patients. In group 1 was the control group and was treated through conventional physical therapy program, group 2 was the study group and was treated through the virtual reality box 360 kinect training for 30 minutes in addition to the conventional therapy on same day. All treatments were applied for 3 days a week for 6 weeks by the same physiotherapist.

Participants practiced while standing approximately two meter from the screen to facilitate the positioning by the infrared camera sensor. Patients trained Bowling programs by the affected upper limb for 30 minutes for 6 wks of the study, the game program and instructions were well explained for all patients. Patients were asked to reach to their left or right hand to pick up a ball before swinging their arm forward to bowl.

The subjects voluntarily agreed to participate in the study after the study's purpose and methods were explained. Hand strength was measured by grip. Grip strength was measured by Jamar hand held dynamometer. This instrument is scored using force production in kilograms (0-90). Tha starting position of the patient was sitting with back, pelvis, and knees as close to 90 degrees as possible. Shoulder was abducted and neutrally rotated, elbow flexed at 90 degrees, forearm neutral, wrist held between 0-15 degrees of ulnar deviation. The arm was not supported by examiner or armrest and the dynamometer is presented vertically and in line with the forearm. Subjects were asked to grip as firmly as possible for 3 seconds to register maximum reading with 60 second rest periods between trials to avoid fatigue. Dynamometer calibration was required for achieving accurate measurements. ADLs were evaluated using SHAH version of the Modified Barthel Index which comprises 7 self-care activities and 3 mobility activities. It has three different rating scales: a score range of 0-5 (bathing and personal hygiene), a score range of 0-10 (feeding, dressing, toilet use, bladder control, bowel control, and stair climbing), and a score range of 0-15 (chair/bed transfers and ambulation). A higher score represents a higher degree of independence in performing basic ADLs.

Statistical Analysis:

A statistical package program was used to evaluate the data obtained from the study. Descriptive statistical methods (frequency, proportion, mean, and standard deviation) were used in the evaluation of research data as well as the Kolmogorov–Smirnov distribution test for examining normal distribution. The Pearson chi-square test was used in comparing qualitative data. In comparing quantitative data, the unpaired samples t-test was used in intergroup comparison of parameters. The Paired samples t-test was used for intragroup comparisons. The results were calculated at the 95% confidence interval, $P < 0.05$ significance level and $P < 0.01$ advanced significance level.

RESULTS

No study participant left the research project for any reason. No side effects or complications were observed during the treatment. Baseline characteristics of the patients are shown in Table 1. The control group included 17 males and 13 females patients, and the study group included 21 males and 9 females patients. The control group included 19 right side and 11 left side patients and the study group included 17 right side and 13 left side. The average age was 59.8 ± 5.92 years in the control group and 57.3 ±4.99 years in the study group. The average duration of illness was 9.67 ±4.08 months in the control group 10.4± 4.2 months in the study group.

No statistically significant difference was found between the 2 groups in terms of age, sex or side of affection ($P > 0.05$). The increase in the modified Barthl index score for the control group at the end of the treatment was statistically significant in comparison to baseline ($P < 0.05$), as shown in Table 2. The increase in the modified Barthl index score for the study group at the end of the treatment was statistically significant in comparison to baseline ($P < 0.05$), as shown in Table 2.

The increase in the grip muscle strength for the control group at the end of the treatment was statistically not significant in comparison to baseline (P > 0.05), as shown in Table 3. The increase in the grip muscle strength for the study group at the end of the treatment was statistically significant in comparison to baseline (P < 0.05), as shown in Table 3. The increase in the modified Barthl index score for the control group at the end of the treatment was significantly lower than in the study group (P < 0.05), as shown in Table 4.

Table 1.Baseline characteristics of the patients.

Characteristics	Control (n = 30)	Study (n = 30)	P
Age (years, mean ± SD)	59.8 ± 5.92	57.3 ±4.99	.086
Duration of illness (months, mean ± SD)	9.67 ±4.08	10.4± 4.2	.495
Sex (female/male)	13/17	9/21	.284
Side of affection (right/left)	19/11	17/13	.598

Data are presented as mean ± SD or number of patients.

Table 2.Modified Barthl index scores pre and post treatment for both groups.

Modified Barthl index scores	before	after	P
control	71.77 ± 13.85	76.24 ± 13.67	.000**
study	66.37 ± 12.5	83.37 ± 13.17	.000**

Data are presented as mean ± SD. **P < 0.01.

Table 3. Grip strength pre and post treatment for both groups.

Grip strength	before	after	P
control	10.69 ± 5.83	10.84 ± 5.83	.356
study	11.84 ± 5.94	14.04 ± 6.49	.000**

Data are presented as mean ± SD. **P < 0.01.

Table 4.Modified Barthlindex scores between groups.

Modified Barthl index scores	Control (n = 30)	Study (n = 30)	P
Baseline	71.77 ± 13.85	66.37 ± 12.5	.118
At the end of the treatment	76.24 ± 13.67	83.37 ± 13.17	.044*

Data are presented as mean ± SD. *P < 0.05.

Table 5.Grip strength between groups.

Grip strength	Control (n = 30)	Study (n = 30)	P
Baseline	10.69 ± 5.83	11.84 ± 5.94	.452
At the end of the	10.84 ± 5.83	14.04 ± 6.49	.049*

Data are presented as mean ± SD. *P < 0.05.

The increase in the grip muscle strength for the control group at the end of the treatment was significantly lower than in the study group (P < 0.05), as shown in Table 5.

DISCUSSION

Stroke patients with hemiparesis complain of reduced upper extremity function after stroke (Persson et al.,2015). Stroke patients show slower upper limb functional recovery than the lower limb (Secretariat and Ontario 2011). The authors investigated the effect of additional VR training using Xbox Kinect training on the function of the upper extremity in patients with stroke. Modified barthl index scores significantly increased from baseline both in the patients who participated in VR training and in the control group. While Grip strength measured by hand dynamometer significantly increased from baseline only in the patients who practiced in VR training.

Many researchers have previously reported the effects of VR training in stroke individuals. Kuttuva et al. investigated the effects of the Arm virtual rehabilitation in one patient had chronic stroke 17 months after the onset of disease and reported significant increase in shoulder flexion and extension ranges of motion and also theFMA score improved after 4 wks of virtual reality training (Kuttuva et al.,2006).

Xbox Kinect (Xbox 360, Microsoft, United States) was used for the VR training. Xbox Kinect is a video game device that collects the user's movement via infrared camera sensors. Unlike other game devices, with Xbox Kinect, the users can see the VR environment without the need for a special controller, and their movement is captured in real time providing immediate feedback. Patients with impaired fine motor skills can participate effectively in the game as there is no need for special buttons used. The apparatus provides the patient with visual and auditory feedback about his performance or when the task is not properly performed (Sin H and Lee 2016).

It was reported that the upper extremity motor function scores improved significantly (p < 0.01) at 4 weeks of VR training. There were also significant (p < 0.01) differences in the FMA items after treatment (Lee 2015). Henderson et al.,) and Broeren et al.,) reported improved manual dexterity, grip force, and control of the affected upper limb in stroke patients in the group received VR training more conventional therapy or no therapy after training (Henderson et al.,2007, Broeren et al.,2004).

(Jang et al.,) reported significant effects of VR training on arm and hand motor function in patients with chronic stroke with mild to moderate impairment (Jang et al.,2005).(Lee, 2015) reported significant improvement in ADL performance and upper extremity motor function between the before and after assessments (Lee, 2015). Similarly, Lee reported that VR using video games resulted in significant improvements in the upper extremities muscle strength and ADL performance (Lee and Lee 2013). Motion controlled video games have a positive outcome in improving the upper extremity of stroke survivors when combined with conventional physical therapy (Shires et al.,2014). Strong scientific evidence supports that virtual reality (VR) can be used in the field of rehabilitation and physical therapy to improve the functional motor abilities of the upper limb in patients' with stroke. (Diz and Prieto 2016).

The literature supports that the use of virtual reality gaming rehabilitation therapy has equal effectiveness with the traditional therapies (Yates et al.,2016). Additional VR Xbox Kinect training can be used as a method of rehabilitation which can improve the upper extremity function in post-stroke individuals. The effects reported by the VR training may be due to the total intervention time (Sin and Lee 2016). Holden et al.,) studied 2 subjects and reported little to no change in ADL performance after VR training. As VR programs use repetitive movements of the upper extremities while fine motor movements of the hand, such as catching and moving things, are usually included for the performance of ADL(Holden,2005).

CONCLUSION

This study demonstrated that there was a significant difference between the two groups in the grip muscle strength measured by hand dynamometer and Barthl index scores after six weeks of intervention in favor of study group.

CONFLICT OF INTEREST

The authors whose names are listed immediately below certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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AUTHOR CONTRIBUTIONS

MMM, MAand MR designed the research work, helped in the patients' selection and the assessment procedures for the patients. MA made the patients referral. MMM and MR performed thetreatment procedures for the patients. MMM wrote the manuscript and made the data analysis. All authorsreviewed the manuscript and approved the final version.

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