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Physiotherapeutic Effects of Joystick Type Video Game Versus Mirror Therapy on Motor Recovery of Upper limb Post Stroke

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ABSTRACT

Background: Stroke is sudden onset of focal neurological deficit lasting for more than 24 hours duration the term referred to stroke. The World health organization definition of a stroke is a rapidly developing clinical sign of focal disturbances of cerebral function lasting more than 24 hours with no apparent cause other than that vascular origin. Stroke is one of the major leading causes of death and disability in India. Stroke is a common global health-care problem that is serious and disabling. The most common and widely recognized impairment caused by stroke is motor impairment, which can be considered as a loss or limitation of function in muscle control or movement or a limitation in mobility. So, this type of impairment affects a person's ability to perform and complete the daily activities. Upper extremity motor function improvement after stroke is difficult and confusing.
Objective: Primary objective is to evaluate the effect of game-based rehabilitation on upper extremity functions in stroke survivors and the secondary objective is to explore the patient experiences of using game-based rehabilitation as a medium in rehabilitation.
Methodology: Randomization was done with SNOSE allocation method, allocated 24 patients equally into two groups 12 experimental and 12 control. It was a single-blinded study. Outcomes measures ARAT was used for assessment of hand function. The total intervention time period was 4 days per week for 5 weeks. The assessment was taken at 3 times baseline post at 2 ends of the 2nd week and after 5weeks.
Result: There was no significant improvement in any component of ARAT (all four components of ARAT scale), within subjects, within the group, in between group and both groups significance of P value being more than 0.05.in all components.
Conclusion: In conclusion the joystick video games are interesting but when it comes to the patient point of view it requires minimal muscle power is required to control the game. So further studies are required with large sample size, more duration and most sensitive outcome measure to find out the minimal changes motor recovery in hand functional activities.
Keywords: Stroke, Motor recovery, game therapy, video game therapy.

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INTRODUCTION

Background

The term 'stroke' is synonymous with Cerebro Vascular Accident (CVA). The World health organization definition of a stroke is a rapidly developing clinical sign of focal disturbances of cerebral function lasting more than 24 hours with no apparent cause other than that vascular origin. Stroke is one of the major causes of death and disability in India(Pandian et.al 2013).

Stroke is the one of the most common health maintenance problems around the worldwide that is a very serious and disabling condition. Most of the patients with stroke survive was the beginning damage. It largely effects on patients which is usually through long-term disability, restriction of activities and reduced participation. The most frequent and widely identified impairment caused by a stroke was motor impairment, which is also considered as a loss or restriction of function in muscles that leads to decrease in muscle function and limitation in mobility. This motor function loss can be originated by an ischemic or hemorrhagic lesion to the areas in the motor cortex, premotor cortex, motor tracts, or related pathways in the cerebrum or cerebellum. This type of impairments influences an individual's ability to complete daily activities (Langhorne P et.al 2009)[2].

After a stroke, the motor impairment will definitely affect the control of the following functions such as movements of the face, arm, and leg of one side of the body and it usually affects around 80 percent of patients(Rand D et.al 2014).

In post-stroke patient's motor recovery is complex and unclear. There were many types of treatments have been evolved to try for improvement in motor functions i.e. recovery from impairment and associated functions. There are many randomized controlled trials and systematic reviews have been done on this area(Pollock A et.al 2014).

The main target in post-stroke patients was upper extremity function. In recent years, video games were popular in video game-based therapy. Which is commonly used in both research and clinical settings? Video games were initially designed for recreation, but recently some collective video games have been specially designed for rehabilitation (Saposnik G et.al 2011). It helps to provide the participant with multisensory feedback which requires a various level of action from the participant. Although there is a lack of information and facts regarding the efficacy of video game-based therapy and virtual reality training in rehabilitation, the high quality and the low cost of the commercial consoles are the main reasons for the increased attention reserved to their use of video games in clinical and research settings(Thomson K et.al 2016).

Gaming is a fun and meaningful activity which patients enjoy (Standen PJ et.al 2018). It motivates patients to participate in their rehabilitation and it offers a variety of particular use for stroke patients to be able to give a fun alternative to more than traditional treatment methods. Gaming can be played with others encouraging social interaction and competition. Gaming can encourage upper limb movement and coordination as well as develop other skills and function. It can be a good way of encouraging movement using a fun activity(Lohse KR et.al 2014). Self-practice and families often have access to gaming and patients could continue rehabilitation at home easy to set up and use. There is a need to incorporate video game therapy to stroke patients which is cost-effective, more enjoyable to patients and to improve upper extremity function(Shin J-H et.al 2016).

Objectives of the study

Primary objective - To evaluate the effect of game-based rehabilitation on upper extremity functions in stroke survivors.

Secondary objective - To explore the patient experiences of using game-based rehabilitation as a

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medium in rehabilitation.

METHODOLOGY

Study design: RCT (Randomized Control Trial)

Allocation ratio N2/N1=1 No. of groups = 2
Total sample size = 24

Inclusion criteria

1. Post Stroke Both male and female clients with sub-acute stroke to chronic (15 days to 6 months).
2. Individuals with age ranging from 30 – 70 years.
3. The patients who have voluntary control grading grade 2 to grade 5.

Exclusion criteria

1. Individuals who had undergone recent upper limb surgeries.
2. Individuals with upper extremity fractures.
3. Individuals have been diagnosed with cognitive impairments.
4. Dislocation and subluxation of the shoulder of Grade II & III.

Outcome measures

1. Action research arm test (ARAT).
2. Materials required
3. Lenovo Laptop.
4. Logitech extreme 3d pro gaming joystick.
5. Power Socket.
6. One table and one chair.
7. Mirror box.

PROCEDURE

Written informed consent was given to all patients who were potentially eligible for the study. Patients were selected based on inclusion and exclusion criteria and their willingness to participate. Twenty-four patients were recruited for the study. The patients were allocated in the experimental group (12) and the control group (12) using block randomization method. The randomization was done by the person who is not involved in the study. Baseline measurements of ARAT were done by (Tester- 1). The neuro physiotherapist (Tester-2) gave the game therapy for experimental group as well as the control group received conventional treatment.

The experimental group (Game therapy)

Before going to the main study, a pilot study on normal subjects and patients was done to standardize the operating procedure. After the pilot study, we modified the procedure and duration of game therapy based on the problems faced. The position of the patient is sitting in a chair and the joystick was placed on the stool, keeping in front of the patient at a comfortable position to the appropriate patient height.

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The laptop was placed on a table in front of the patient with a minimum distance of 1 meter. The game played was Ace combat, before playing the game the clear Instructions was given to the participants about the handling of joystick, game, levels, targets, and goals of the game. The total duration of the session was 30 minutes period. The first 5 minutes for instructions and a trial period of 5 minutes was given to the patients who played for the first time. Once done with the trail, patients played the game for 30 minutes as per instructions. The 30 minutes duration was divided into 15 minutes for unaffected hand followed by 5 minutes of rest and then 10 minutes for affected hand. The patient starts the game with unaffected hand followed by affected hand.
The patients played the game as per commands are given by the therapist. In this game, the jet plane has to be moved using the joystick to be followed by finding and shooting of enemies is the task. The total duration of the intervention was 4 days a week for 5 weeks.

Plate 1.Trail on normal individual's

Plate 2.Trail on normal individuals

Plate 3.Playing game by a stroke patient

Plate 4.Playing game by a stroke patient

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Plate 5.Playing game by a stroke patient Plate 6.Playing game by a stroke patient

The control group (Mirror therapy)

The position of the patient was sitting position in a chair, mirror box placed on the table at the patient height. Patients can watch the mirror image of unaffected arm. The patient keeps the affected arm inside the box and unaffected arm outside the box. During the therapy, the patient should watch the mirror and observe the image and follow the commands given by the therapist. Before starting the therapy, instructions were given to the patient that the patient should watch the mirror while doing the exercises.

The exercises that are given to the patient was fingers flexion and extension, wrist flexion-extension, opponents of all fingers, supination, and pronation of hand, writing or drawing circles, squeezing ball. Each exercise duration for 2 minutes and the total duration was 30 minutes. After completing one set of exercise i.e.12 mins of exercise and 6 mins of the rest period, again one more repetition of exercises was given. The total duration of this intervention for the control group was for 4 days a week for 5 weeks.2

Plate 7. The patient was doing mirror therapy exercises

Plate 7. The patient was doing mirror therapy exercises

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RESULT

Participants

A total of 24 four patients were included in the study, all participant had completed the study protocol twelve patients in experimental and twelve patients in the control group. The two group's demographical data manage, duration of the stroke, distribution of right and left hemiplegia were showed in table 2. The average age distribution in the experimental group is 50.83 and 48.75 in the control group. The standard deviation of both the groups was 49.38 ±7.950 years. The duration of stroke in months was 4.25 months in the experimental group and 3.66 months in s conventional group. The standard deviation of both groups was 3.96 ± 908. The right-handed affected patients were 10 and left-handed patient were 14.

Table 2.Demographical data of both experimental and control group patients.

Figure 7. Study flowchart

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Outcome measures

The outcomes values were taken at the three times in whole intervention period of 5 weeks, that was a baseline, after 2 weeks and post-intervention i.e. is after 5 weeks. The scores of the patients from baseline to post-intervention there was slightly increased but it was no increased and it's not significant statistically improvement in both groups and within the groups, the p-value is more than 0.05, there were no significant differences in the scores of all the ARAT in all components (= > 0.05).

The mean and standard deviation of grasp component in baseline and post- intervention that is after 2 weeks are given in table 3. The comparison between the baseline and post line of both experimental and control group. The mean and slandered deviation in the control group were showing no significant improvement in all 4 components of the ARAT scale. There is a minute deviation in total seconds of 4 components in scale i.e. after 5 weeks. There is no difference in score in all components within the subjects.

Table 3: The mean and standard deviation of outcome measures scores in the Experimental group at baseline, post, and final.

Mean and standard deviation of Control group (baseline, post line, final)				
Sl. no.	Component, Score, Time	Baseline mean and slandered deviation	Post line mean standard deviation	The final mean standard deviation
1	Grasp Total score	15.50 ±3.090	15.00±3.133	15.00±3.133
	Grasp Total sec	73.917±97.3012	96.758± 107.32	92.975± 104.56
2	Grip Total score	10.33±2.060	10.00±2.089	10.00±2.089
	Grip Total sec	50.22±65.026	207.183±553.69	62.830 ± 70.99
3	Pinch Total score	11.00±65.026	10.75±3.49	10.67±3.447
	Pinch Total sec	188.5±116.10	189.35±116.37	209.847 ± 106.74
4	Gross Total score	8.00±1.47	8.25±1.86	8.00±1.477
	Gross Total sec	16.108±18.56	44.39±91.93	16.450±18.7508

Table 4.The mean and standard deviation of outcome measures scores in the Experimental group at baseline, post, and final

Experimental group mean and standard deviation of the baseline, post, final				
Sl. no.	Component, Total Score, Total time	Baseline mean and Standard deviation value	Post line means and the standard value	Final mean and standard deviation
1	Grasp Total score	12.33±3.08	12.58±2.906	12.83±2.480
	Grasp Total sec	20.908±106.2641	202.57±103.029	348.508±564.1292

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2	Grip Total score	7.80±1.931	7.67±1.826	8.08±1.505
	Grip Total sec	137.275±53.223	8.92±4.461	131.383±57.8251
3	Pinch Total score	8.92±4.461	9.0±4.328	9.83±4.629
	Pinch Total sec	230.892±116.73	239.45±115.9	234.242±115.8082
4	Gross Total score	6.75±1.357	6.75±1.357	6.75±1.357
	Gross Total sec	69.117±47.67	64.67±1.357	56.725±39.2835

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In the above table 4, there was no difference in baseline to final mean and standard deviation in the experimental group. Showing no significant improvement in scores of all 4 components of the ARAT scale. But there was a small change in total scores of grip and pinch from baseline to final. There was also a minute deviation in total seconds of grasp Grip components in scale i.e. after 5 weeks. There is no difference in all score in all components within the subjects.

Table 5.Comparison from baseline, post and final outcome measures values of within subjects (experimental and control group)

Experimental and Control group f values and p values (within subjects)							
Sl. no.	Component, Total Score, Total time	Baseline F value	Baseline P value	Post F Value	Post P value	Final F value	Final P value
1	Grasp Total score	.132	.720	.132	.720	.131	.721
	Grasp Total sec	.105	.749	.844	.369	.051	.824
2	Grip Total score	.125	.727	.404	.532	.896	.355
	Grip Total sec	.155	.698	.073	.790	4.330	.050
3	Pinch Total score	.221	.643	.377	.546	.513	.482
	Pinch Total sec	1.483	.237	.500	.487	.500	.487
4	Gross Total score	.848	.367	.057	.814	.693	.415
	Gross Total sec	.227	.639	.332	.570	.076	.786

In the above table 5, the p-value and f values of within the subjects of two groups were showing that there was no significant difference in all components of ARAT in 24 patients.

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Table 6. Comparison from baseline, post and final outcome measures values of within groups (experimental and control group)

Experimental and Control group all f values and p values (with in group)							
Sl. no.	Component, Total Score, Total time	Base line F value	Base line P value	Post F Value	Post P value	Final F value	Final P value
1	Grasp Total score	1.066	.314	.020	.888	2.335	.141
	Grasp Total sec	5.140	.034	2.349	.140	.986	.332
2	Grip Total score	3.445	.078	2.414	.135	.041	.841
	Grip Total sec	1.749	.200	2.056	.166	1.620	.217
3	Pinch Total score	.497	.488	2.247	.149	.051	.823
	Pinch Total sec	.155	.698	4.429	.048	2.608	.121
4	Gross Total score	3.617	.071	.005	.945	4.262	.052
	Gross Total sec	.891	.356	2.063	.166	2.921	.102

In the above table 6. It's a comparison between two groups from the baseline to post and final. The p-value and f values of between two groups show there was no significant difference in all components of ARAT

Table 7. Simple paired t-test, compression in between groups (Experimental and control)

Experimental and Control group t values and p values (in between group)			
Sl. no.	Component, Total Score, Total time	Comparison between the baseline to post within groups p values and t values	
		t value	p-value
1	Grasp Total score	.000	1.000
	Grasp Total sec	-1.020	.318
2	Grip Total score	-.549	.588
	Grip Total sec	-.968	.343
3	Pinch Total score	-.762	.454
	Pinch Total sec	-1.201	.242
4	Gross Total score	2.495	.020
	Gross Total sec	-435	.034

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After doing of repeated measures of ANOVA we got to know that there is no significant difference in within subjects and within the group, so we did a simple paired t- test to find out there is any significant difference in between groups but we found that there is no significant difference in between groups also. Here we concluded that there are no values of above given in tables were not showing any significance i.e. (P = >0.05).

DISCUSSION

Our results showed that a video game based therapy performed using Logitech extreme 3d pro joystick is not significantly effective in enhancing the hand functions and upper extremity functional activities. In above the review of some studies done on a video game based therapy with high ended devices like (VR, SONY PLAYSTATION) used to improve hand functions and those are showing improvement, that may be due to the high sensors, more graphics and number of session duration of the game may influence their Improvement (Vinas-Diz S et.al 2016). Whatever studies done up to now is also used high ended devices then we come up with a new idea of using joystick video games to improve in upper extremity functions (Shin J et.al 2014). For that we reviewed some systematic reviews Cochrane reviews. They concluded that game therapy is a significant improvement in hand functioning. As a reference of above studies, we proceeded with joystick type of game therapy which is easily available and cost-effective. Then we were searching for the low- cost joystick, finally, Logitech Company had to provide many types of joysticks in that one type of joystick which is low cost to buy i.e. Logitech extreme pro 3D.

At the beginning of this study, we found the difficulty of finding games for compactable to the joystick and interesting to play for patients, after searching of many different games to suit the patients as well as a joystick, then we selected a game called Ace Combat. Ace combat is suitable for joystick and it's easy to play and understand the game for the patient. Once the selection of game, we did a trail on normal subjects to find out the difficulties of the game and interest towards the game. We found that the game is an interesting and challenging totem, they gave feedback about game and gaming experience (Barrett N et.al 2016). Then we did a pilot study on 3 stroke patients to find any difficulties, interesttowards the game and also for standardizing the standard operating procedure. There we found that patients have more difficulty to hold the joystick continuously for 13 minutes with affected hand, sitting and placement of laptop and joystick position(Standen PJ et.al 2017). After the pilot study, we modified the duration of gaming that is 15 mints to unaffected side and 10 mints to affected side with in-between 5 mints rest. We added a trial period of 5mints for who is playing the first time. The placement of joystick and laptop was changed with respect to the subject height.

Once the pilot study did, we started the recruiting the patients into the study where we had a problem with different age groups acute stroke cases which did not meet my inclusion criteria and many people are not locals, they were not able to come for 4 days per week up to 5 weeks. Then later we recruited who is willing to participate in the study. Most of the people who are willing to participate in this study were staying within 7 to 10 km distance from the hospital. Some of the people were not educated and they had no idea about games and they said not interested to play games that to affected hand. Lateran, screening, and patients were recruited according to the SNOSE allocation method with single blinding. The recruited patients were distributed into two groups i.e. Control and experimental, intervention in both groups started at the same time. We took all the requirements for game therapy and portable, foldable mirror for mirror therapy to the patient house. We have modified the height of chair and table according to the patient comfort in their home with pillows. In the experimental group, patients felt difficulty while playing during the initial first few days i.e. is

the 1st week. We had given a trial period of 5 mints for every patient up to one week and giving them continues commands while playing the game, for familiarizing and understanding the game and how to control
the joystick. Each session 30 minutes of game therapy for the experimental group and 30 minutes for the control group up to 4days per week for 5 weeks. In both groups, the total no of hours spent by each patient in 20 sessions was 10 hours.
Due to the lack of education or lack of interest on games patients were started reducing the game duration with a greater number of missions fails in game and they were completing half an hour duration of game with both affected and unaffected side hand. We faced the problem of carrying equipment to every once housing and in Indian setup there were different type of chairs and tables so it's very difficult to standardize the chair and table for the game therapy as well as mirror therapy. Few people showed interest, they were educated and they had previous gaming experience in their mobile and computer system. After observing this we found that there was a lack in understanding of gaming in uneducated patient and previous experience of gaming also effects on interest. To attain the patient attention toward games it requires high ended devices with full sensors along with games contain high graphics which will give much more attention and interest to the patient for play the gaming and it's easy for the patients to control also.
There might have been a chance of improvement if we could have increased the number of session of the games, duration, and recruitment of patients based on the dominant hand. Other factors like the duration of the stroke, type of stroke, cognition, including upper extremity function measures such as joint range of movement, hand motor function, grip strength, and dexterity may affect directly or directly on the result which we didn't consider. The result of this study showed no significant improvement in within subjects and between groups. While doing analysis, we faced a problem in entering into SPSS there are four subcomponents outcome measure and it consists of
score and time, it will become eight variables, which had to be repeated 3 times (0 weeks, baseline, 2nd week post, and 5th week final values).after entering into the SPSS all the values the analysis was done(Levac D et.al 2015).
There was another major problem with the ARAT outcome measure which all most all patients got the same score from baseline to post and there is a change in time taking to perform the task, in during analysis also we faced problem to put so many variables for calculate both scores and time so it's quite a little bit difficult and confusing while analyzing data. As per p-value there is no significant improvement in total score of all components in ARAT and according to total seconds of all components there are changes in time taking to complete the task, but it won't be considered as an improvement. Because it's very minute that to in seconds, so measure the minute improvements which were observed in reduction of time taken to complete in ARAT the task but did not show statistical significance.
Strengths

The main strength of this study was a cost-effective gaming device and feasible for this study, it occupies less space, and portable type and easy to set up. Interesting to the patients who had previous gaming experience and few are enthusiastic towards the game to play.
CONCLUSION

This study concludes that the joystick type video games are interesting but when it comes to the patient point of view it requires minimal muscle power is required to control the game. So further studies are required with large sample size, more duration and most sensitive outcome measure to find out the minimal changes in hand functional activities.

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