RESEARCH ARTICLE

Occupational therapy rehabilitation of industrial setup hand injury cases for functional independence using modified joystick in interactive computer gaming in Anand, Gujarat

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ABSTRACT

Background: The prevalence of hand injury cases in India from road traffic incidences is about 30% and the total number of hand injuries would go higher on adding the industrial injury cases. Several studies have provided preliminary descriptions of the benefits of virtual reality and video games in rehabilitation training. There are many studies showing beneficial utility of video games in rehabilitation and improvement of functional independence of the hand injury patients using high-cost video game such as "Wii" and others. **Aims and Objectives:** This study aims to find the impact of low-cost video game therapy against the conventional therapy in improving the hand function in terms of range of motion, grip strengths, and functional independence. **Materials and Methods**: Patients coming to occupational therapy unit with hand injury fulfilling inclusion-exclusion criteria and agreeing to participate in the study were randomly divided into two groups - conventional therapy group and video game group based on the computer-generated random allocation. The duration of therapy was same for the two groups. The readings for hand function in terms of range of motion, grip strengths, and functional independence were documented for both the groups before the treatment and after the treatment and were compared statistically for finding the difference if any. **Results:** The findings of the study showed that both the groups had improved in terms of the hand function as in the range of motion, grip strengths, and functional independence at the end of treatment irrespective of the treatment arm they were in $P < 0.001$. Comparison between the two treatment arms revealed that there was no statistical difference between the improvements documented in the two groups and the improvements were not statistically significant ($P > 0.05$). However, the experimental group seemed to enjoy their treatment more than their counterparts as expressed in informal communications; therefore, we may conclude the gaming method to be more preferred method of the treatment for the condition. **Conclusion:** We conclude that the video gaming method is as effective as that of the conventional method for improving the strengths, grip, range of motion, and functional independence in hand injury cases, but the video gaming being more interesting and involving, is deemed to be much more enjoyable by the patients compared to the conventional. Since the patients find it interesting, they look forward for more of the sessions. This is a positive motivation for the compliance of the patients for completing the treatment properly and getting maximum benefit of the therapy.

KEY WORDS: Occupational Therapy; Video Game; Hand Injury; Rehabilitation; Modified Joystick

INTRODUCTION

The prevalence of hand injury cases in India from road traffic incidences is about 30.2% and the total number of hand injuries would go higher on adding the industrial injury cases. Several studies have provided preliminary descriptions of the benefits of virtual reality and video games in rehabilitation training.[1] There are many studies showing beneficial utility of video games in rehabilitation and improvement of functional independence of the hand injury patients using high-cost video game such as "Wii" and others,There are many studies showing beneficial utility of video games in rehabilitation and improvement of functional independence of the hand injury patients using high cost video game like 'Wii' and others, using popular commercial video games in therapy with children and adolescents.[2] The utilization of such high-end games for rehabilitation purpose by the middle to lower socioeconomic status patients is a problem due to its cost involved.

The current study, therefore, was taken up to find if modified video games with locally available recourse, also can increase the range of motion and the functional independence in the patients significantly to help the therapist rehabilitate these patients optimally within their economic comfort zone.

Objective of the Study

The objective of the study was to document the improvement in the functional independence, range of motion, and gross and fine motor power grip strength of dominant hand in conventional therapy group and innovative video game therapy group that will use the modified joystick and video gaming for rehabilitation and also compare the improvement in these parameters across the two groups to find which group stands better.

MATERIALS AND METHODS

Study Design

This was a randomized controlled trial study.

Participants

All adults age group of 18–40 years, both male/female patients having hand injury due to fracture, crush injury, or tendon injury.

Exclusion Criteria

Patient with any psychiatric comorbidity and/or hemiplegic conditions, and/or having severe sensory loss condition were excluded from the study.

Sample Size

A total of 64 patients (32 in each group) assuming standard deviation of 0.9 and 0.7 in the two groups, respectively, to detect a difference of 0.7 units as 5% level of significance and 90% power. Sample size calculated using WINPEPI software. Assuming some attrition, 66 (33 in each arm) was the sample size considered.

Methodology

The study was duly approved by the Human Research Ethics Committee, Charutar Arogya Mandal, Karamsad. The participant fulfilling inclusion-exclusion criteria were explained about the study. Written informed consent was obtained from the participants and they were randomized into two groups based on the computer-generated plan of randomization. The intervention group was taken for the conventional therapy for the first 15 min and then was made to play video game for next 15 min every day, 6 days a week for 2 weeks. All the intervention group participants were given the same video game with the use of the modified joystick, while the control group received only the conventional therapy for 30 min daily, 6 days a week for 3 weeks. The game used for therapy was "CARS" that has a rating of E10+. As the game's rating is E 10+, it is non-violence, interesting, and animated game such that it can be used by all the patients without any harm.

The baseline readings for functional independence range of motion, fine and gross grip strengths, and quality of life data were collected using functional independence measure (FIM) scale, goniometer, and JAMER hand dynamometer at the beginning of the study from the participants, and the same was documented again at the end of their treatment plan. The scale FIM was used for data collection after obtaining permission for administration for the purpose from the concern authorities.

The participant in this study was all adults with limited wrist and hand function.

The functional limitation and the range of motion and hand power were checked by the use of FIM scale, goniometer, and JAMER hand dynamometer. The entire participant was given the same video game with the use of the modified joystick. The intervention group participants received 15½-h therapy sessions, 3 sessions a week, along with the physiotherapy and occupational therapy sessions. On the other hand, the control group received solely physiotherapy and occupational therapy as per the conventional regime. Configurable difficulty level parameters were included in the system, which allowed participants to remain competitive by matching game. After 15 sessions for each group in their respective treatment regime, again the assessment was done to compare the changes across the groups and also within the group's pre and post.

RESULTS

There were 65 participants recruited in the study; 33 in experiment group and 32 in conventional therapy group.

Majority of the participants were male (53 males and 12 females). The occupation of the participants mainly was service (35 of 65). Two people mentioned that they were retired while seven were students, nine were homemakers, and remaining were businessmen.

Majority of the cases were for tendon repair (53 of 65 or 81.5%) and the others included platting (five cases), conservative management (three cases), and one case of ligament repair. There were three cases that did not need any surgical intervention. They were managed conservatively.

Most of the people had their right hand affected (44 of 65) and also most had right hand dominant (58 of 65). There were about 70% of cases where the affected hand was dominant (45 of 65).

All the patients showed remarkable improvement in the gross and fine grip strengths at the end of the study [Table 1]. The group-wise distribution also showed significant improvement within the groups pre to post [Table 2]. The improvement observed in the experimental group was as good as the conventional group meaning the grip strengths improved comparable across the two groups [Tables 3 and 4]. There was very good improvement observed in the dynamometer, pincho-meter, and wrist functions in both the groups independently. This means that both the methods improved the grip strengths and range pf motion. [Table 3].

Table 1: Overall improvement in gross and fine grip strengths across the two visits

Grip	Baseline	Endline
Gross grip		
Poor	64	1
Fair	1	29
Good	0	35
Fine grip		
Poor	64	
Fair	1	30
Good	0	35

Table 2: Group-wise improvement in gross and fine grip strength across the two visits

Grip	Conventional group		Experimental group	
	Baseline	Endline	Baseline	Endline
Gross grip				
Poor	32	0	32	0
Fair	0	14	1	15
Good	0	18	0	18
Fine grip				
Poor	32	0	32	0
Fair	0	14	1	16
Good	0	18	0	17

The comparison of sensory functions before and after in the two groups separately did not show any change in the 2PD readings. This is very logical as the sensory function needs long-term interventions, and the intervention duration of about 20 days is not enough for the same.

When the wrist range of motion and hand grip strengths were compared using independent sample t-test on the difference scores, it was found that the dynamometer and pincho-meter reading improvements were comparable across the two groups while the wrist range of motion was found to be better in the conventional group than the interventional group. The level of significance that is generally taken as 5% is adjusted for the multiple comparisons that are made in the study. Applying Bonferroni correction, the conventional group showed statistically significantly higher ROM of wrist compared to the experimental group. Reason for this could be the passive movement of wrist that the conventional group was given that the experimental group did not have. In place of the passive wrist movement, the experimental group was given joystick to move the car in the game as per requirement. It apparently is less effective in improving ROM of wrist compared to the conventional passive movement that the conventional group got [Table 4].

As seen earlier within the two groups, the sensory function is comparable, same way the comparison of motor function between the two groups also did not show any statistical significance [Table 5].

There was no association found between patient being functionally dependent or independent to their affected hand status whether dominant or otherwise (a Chi-square $P > 0.001$) [Table 5]. Most of the patients had attained independence with at the most minimal assistance requirement irrespective of whether their dominant hand was affected or the other one. Functional independence is defined on the scores assigning ranks to the categories, namely total assistance with helper marked least as "1," maximal assistance with helper marked as "2," and so on up to complete independence with no helper marked as "7."

The total score for the FIM motor subscale (the sum of the individual motor subscale items) will be a value between 13 and 91. Therefore, considering a score of 4 or above as mark of functional independence, score of 52 was assumed to be the cutoff of functional independence.

There was also no association found between being functionally independent to the treatment group - conventional or intervention ($P = 0.303$) [Table 6].

However, exploring the relation with FIM at the first visit across the two treatment groups revealed that almost half of the patients in the conventional group were already good at FIM score at the beginning while majority of the experimental

Table 3: Before-after mean (SD) comparison of dynamometer, pincho-meter, and wrist range of motion presented group wise

Parameters	Conventional		*P* value con.	Experimental		*P* value exp.
	Baseline	Endline		Baseline	Endline	
Dynamometer	5.41 (3.97)	15.56 (5.79)	<0.001	5.97 (6.04)	15.36 (7.16)	<0.001
Pincho-meter	7.09 (5.06)	14.06 (5.27)	<0.001	5.45 (4.74)	12.94 (4.13)	<0.001
Wrist ext	12.76 (7.47)	33.93 (9.29)	<0.001	9.97 (5.45)	23.03 (7.98)	<0.001
Wrist flex	15.30 (6.27)	36.43 (11.63)	<0.001	11.18 (5.73)	24.70 (8.93)	<0.001

SD: Standard deviation

Table 4: Comparison of wrist range of motion and hand grip strengths between the two groups

Parameters	Conventional group difference	Experimental group difference	*P* value
Dynamometer	10.16 (5.62)	9.39 (6.45)	0.614
Pincho-meter	6.97 (4.58)	7.48 (3.68)	0.618
Wrist ext	21.38 (10.74)	13.06 (7.933)	0.001
Wrist flex	21.22 (11.51)	13.52 (8.30)	0.003

Table 5: FIM category distribution by status of affected hand whether dominant or not

Group	Affected hand status		Total
	Affected hand not dominant	Affected hand dominant	
Experimental group			
Dependent (<52)	2	5	7
Independent (≥52)	7	19	26
Total	9	24	33
Conventional group			
Dependent (<52)	2	1	3
Independent (≥52)	9	20	29
Total	11	21	32

FIM: Functional independence measure

Table 6: Association found between FIM at endline and treatment group

Group	<52 and ≥52		*P* value
	Dependent	Independent	
Experimental group	7	26	0.303
Conventional group	3	29	
Total	10	55	

FIM: Functional independence measure

group was not independent initially and improved their FIM by end of the study [Table 7].

There were informal feedbacks taken from the experiment group participants regarding their experience. It is noteworthy that they expressed not only satisfaction with the treatment but also mentioned that they took keen interest in their treatment as the process was interesting and involving.

DISCUSSION

This study finding suggests that the intervention treatment group is same as that of the conventional treatment group in terms of all the ranges of motions. This is similar to the findings of other studies.[3]

Although the effect of intervention by video game has resulted in same effect as the conventional therapy group, still it is my argument that the video game technique should be used for treatment as this is much more interesting and involving compared to the monotonous conventional therapy. In conventional therapy, the patients get bored in some time as it is monotonous and repetitive. On the contrary, video game shows the very interesting way of treatment. Both the groups have shown significant improvement from pre-treatment to post-treatment. Although the improvement is comparable across the groups, the excitement and satisfaction in the experimental group participants have been observed much more than the other group.

There are several studies that have used Wii games for the same purpose in adult and pediatric neuro and musculoskeletal cases.[4] These games are very costly and are not so easily affordable and available at general settings or settings where occupational therapy services are rendered.[5]

Group	Baseline FIM motor		Endline FIM motor		Total
	Dependent	Independent	Dependent	Independent	
Experimental group	28	5	23	10	33
Conventional group	18	14	9	23	32
Total	46	19	32	33	65

Table 7: Distribution of participants by FIM categories at initiation and endline across the treatment groups

FIM: Functional independence measure

India being a developing country with majority of the population none affording, needs some "Jugad" way of handling the problem under consideration. Therefore, there was a need to implement some innovative and locally modified - affordable and relatively easily available game that did not need much efforts and investment and to apply in service for settings such as small clinics or hospitals for improvement and rehabilitation of different hand injury cases. This method was devised keeping the above points in mind. This was a simple attempt with low difficulty level of the game and not very challenging or competitive in nature in the experimental group with video gaming. The cost of the game is hardly about Rs. 400 that includes the cost of the software for the game in CD and the joystick. This amount is affordable and can be easily invested for the cause by any setting for the benefit of the patients. There is no recurring cost except of some repair that might be needed sometimes. The current game playing is innovated by modifying the joystick to make the wrist move to its maximum functional positions.

Earlier study has shown the effectiveness of these Wii games in stroke patients with different levels of functional independence[6] while in the current study, only hand injury cases were selected for the experiment. In a study by Hootman *et al.*, they had concluded that the robot suite has potential for stroke rehabilitation. Moreover, another study also shows that the Wii or any other video game would be beneficial for the stroke patients.[7] All the studies involving stroke patients show effectiveness of video gaming in neurological cases while in the current study, we found that the video game is effective in improving the functional abilities in musculoskeletal injury cases too to make then independent in their work and life.

In a recent study by Howes *et al.*, nearly all unimpaired participants preferred playing the two-player game modes compared to the single-player one, as they enjoyed talking and interacting with another person. However, there were two distinct player groups: One liked the competitive mode but not the cooperative mode while the other liked the cooperative but not the competitive mode. Unimpaired participants who liked the competitive mode also put significantly more effort into it than into the other modes. Results from impaired participants were similar, with even impaired participants over 60 years old, enjoying competitive gameplay. The participants' personalities roughly predicted

which mode they would prefer, which was especially evident in a poorly matched impaired pair that preferred the single-player mode.[8] In the current study, the gaming was restricted to single person a time and the individual had to cross the different levels of the game progressively. The effect on range of motion, grip strengths, and functional independence during their routine activities was observed to have improved significantly.

In another study, they found significantly greater improvement in upper limb motor function in the higher intensity robot-assisted training group than in the control treatment group. In contrast, upper limb motor recovery did not differ significantly between the lower intensity training group and the control group. These findings suggest that the intensity is the most important parameter of robot-assisted therapy for upper limb motor recovery in patients with chronic stroke. [9] The current study has used only a single intensity "Cars" racing game and still found significant improvement in the motor performances of the participants. This leaves the question of the effectiveness of different intensities in the improvement in performances unanswered. Possible that if there were games developed with these features to modify intensities, the said association could be explored better.

Yet, another study divided the patients to one of three groups: Conventional group, Wii group, and other game groups. In addition to regular 1-h conventional rehabilitation, each group received an additional ½-h of upper extremity exercises through conventional devices, Wii games, and other games, for 8 weeks and found that all of it improved the upper extremity function while the group with Wii games or other games enjoyed the therapy more than the conventional group.[10] The current study showed that the conventional methods as well as the video gaming method improve the motor function of upper limb, but the patients got much more enjoyable experience in the video game group. No conventional group participant ever mentioned the treatment to be interesting and involving in any of the informal talks with them while these were specifically mentioned by the intervention group participants.

In one study done by Levac *et al.*, they found that due to video gaming, the patients gained more and became more independent in their daily activities than conventional.[11] This is said to have happened due to the much more fast movements required in those video games like Wii. However,

the current study does not support this finding as we found that both groups got comparable level of motor and functional independency in their daily activities.[12]

In the current study, we observed that the wrist extension and flexion ranges of motion showed more improvement in conventional group than the experimental group; however, this difference was not statistically significant after adjusting for the multiple comparisons involved in the study. This marginal difference still could be due to the long stretching or sustain stretching in the conventional group that was not given in the experimental group. Hence, for the maximum benefit of the patient, we recommend the use of video games for improving the range of motion and functional independence along with long stretching.

The point for further research could be doing the same study with increased duration of video gaming per session and also increasing the number of sessions for each patient along with long stretching given to them based on this study finding.

CONCLUSION

We conclude that the video gaming method is as effective as that of the conventional method for improving the strengths, grip, range of motion, and functional independence in hand injury cases, but the video gaming being more interesting and involving, is deemed to be much more enjoyable by the patients compared to the conventional. Since the patients find it interesting, they look forward for more of the sessions. This is a positive motivation for the compliance of the patients for completing the treatment properly and getting maximum benefit of the therapy.

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