

Virtual reality based therapy for post operative rehabilitation of children with cerebral palsy

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Abstract: Virtual reality is the use of interactive replication created with computer hardware and software to impart users with opportunities to engage in environments that appear to feel similar to real world objects and events. The commonest rehabilitation program of cerebral palsy children involves stretching, strengthening, mobilization and various other activities, whereas the use of virtual reality based training (VRBT) for rehabilitation of cerebral palsy is not common. To understand the effect of VRBT a study was formulated. Twenty nine subjects participated (study group – 14 and control group – 15). Outcome measures were MACS, PBS, level of participation, motivation, cooperation and satisfaction of the child. Results revealed that balance and manual ability were significantly improved in both the groups (Balance: study: $t=2.28$, $p<0.05$; control: $t=3.5$, $p<0.01$; Manual ability: study: $t=5.58$, $p<0.001$; control: $t=7.06$, $p<0.001$). PBS had significantly greater improvement in the study group ($t=2.02$, $p<0.05$). Level of participation, motivation, cooperation and satisfaction of the child were also reported to be significantly higher among the study group as compared with control group. To the author's best knowledge, this is the first study on using the VR-based therapy for the postoperative rehabilitation of children with CP which need further elaboration with larger sample size.

Keywords: "VRBT", "cerebral Palsy", "balance", "manual ability"

1. Introduction

Virtual reality is defined as "the use of interactive simulations created with computer hardware and software to present users with opportunities to engage in environments that appear to be and feel similar to real world objects and events" [19]. There are varieties of methods by which users can interact with virtual reality technology [15]. To capture this diversity, authors have coined the term "interactive computer play," defined as "any kind of computer game or virtual reality technique where the child can interact and play with virtual objects in a computer – generated environment" [12].

Virtual Reality (VR) technologies have begun to be used as a treatment tool in neuropsychological practice recently [4, 6 – 8]. The use of this technology is moving fast in this field [9, 11]. VR typically refers to the use of interactive simulations created with computer hardware and software to present users with opportunities to engage in

environments that appear and feel similar to real-world objects and events. Users interact with displayed images, move and manipulate virtual objects, and perform other actions in a way that immerse them in the simulated environment thereby engendering a subjective feeling of presence in the virtual world. In the medical field the use of VR and computerized therapies were ranked third and fifth, preceded only by homework assignments (first), relapse prevention (second), and problem solving techniques (fourth) [10]. Studies also showed that the VR treatment was more effective than the traditional cognitive-behavioral psycho nutritional groups in improving the overall psychological state of the patients [10]. Although, virtual reality based training gives lots of opportunities to treat a patient, it is required to ensure appropriate development of VR applications. Clinicians must have a clear understanding of the opportunities and challenges which need to provide to professional practice. Within last six to seven years the use of virtual reality

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based training in the field of psychotherapy and rehabilitation increased a lot [5]. The underlying principle behind its use is very simple. In VR the patient is intentionally dealt with the feared stimuli while allowing the anxiety to satisfy. Because avoiding a dreaded situation reinforces all phobias, each exposure to it actually lessens the anxiety through the processes of habituation and extinction. Moreover, VRE offers a number of advantages over in vivo or imaginable exposure; it can be administered in traditional therapeutic settings, and is more controlled and cost – effective than in vivo exposure.

To achieve a stronger feeling of presence, users are provided with different feedback modalities such as visual and audio feedback. Depending on the characteristics of hardware, software, and task complexity, Virtual Reality Based Therapy (VRBT) aims to provide users with a meaningful experience in the context of the user's therapeutic objectives. VRBT is considered appropriate for rehabilitation because of its well – known assets. These include the opportunity for active learning, which encourages and motivates the participant, the ability to objectively measure behavior in a challenging but safe and ecologically valid environment while maintaining strict experimental control over stimulus delivery and measurement. There are fewer studies available which explains the effect of virtual reality based training (VRBT) on the patients suffering from cerebral palsy. The aim of the study was to evaluate the effect of VRBT on balance, manual ability, level of the participation and satisfaction among the post operative children, suffering from cerebral palsy, who were going through a rehabilitation process.

2. Methodology

Sixteen subjects (postoperative cerebral palsy children) were randomly selected for this study. All subjects were randomly divided between two groups. Eight subjects were in the study group and rests of the eight were in the control group. The study group received VRBT along the conventional rehabilitation modalities, whereas, control group received only conventional rehabilitation modalities.

Nintendo Wii sports [20] and Wii fit [20] were used for virtual reality based training (VRBT). Wii Sports introduces a whole new way to play the game. Play Tennis, Baseball, Golf, Bowling and Boxing in the comfort of one's living room. Use the Wii Remote controller to mimic the actions of swinging a racket,

bat or club, roll a ball down an alley or bring the left jab. Wii Fit is a balance board attached to Wii console features four main categories to choose from: Strength Training, Aerobics, Yoga and Balance Games. Different games were assigned by the physiotherapist according to the need and capabilities of the child among the study group. The subjects of the study group were assigned to play the games (VRBT) in every three alternate days in a week, which is monitored by a physiotherapist for three weeks.

The outcome measures were Manual Ability Classification System (MACS) for upper limb function and pediatric balance score (PBS) for balance. Both the measures were collected before the treatment and after completing the treatment (after three weeks). For statistical analysis SPSS version 17.0 were used.

3. Result

The mean age of the study and control group was 8.88 ± 3.23 and 10.38 ± 4.41 respectively. Table 1 represents the data of mean and standard deviation of MACS and PBS.

Table 1.
Mean and Standard deviation of MACS and PBS
for both the groups

	Study	Control
MACS		
Before	1.71 ± 0.99	2.20 ± 1.21
After	1.43 ± 0.65	1.73 ± 0.80
t-value and level of significance	$t-2.28, p < 0.05^*$	$t-3.5, p < 0.01^*$
PBS		
Before	35.57 ± 12.67	26.40 ± 14.63
After	45.00 ± 8.73	36.07 ± 14.38
t-value and level of significance	$t-5.58, p < 0.001^*$	$t-7.06, p < 0.001^*$

** – Significant

Statistical analysis revealed that there is a significant (study: $t-5.58, p < 0.001$; control: $t-7.06, p < 0.001$) improvement in the PBS score after the treatment for both the groups. Also there is a

significant (study: $t=2.28$, $p<0.05$; control: $t=3.5$, $p<0.01$) improvement of manual ability after the treatment for both the groups.

To understand the effect of the VRBT, the PBS and MACS between the groups were compared before starting of the treatment and after finishing the treatment. The result is presented in table 2.

Table 2.
Statistical analysis of PBS and MACS between the groups

	Study	Control	t-value and level of significance
MACS			
Before	1.71 ± 0.99	2.20 ± 1.21	$t=1.18$, $p>0.05$
After	1.43 ± 0.65	1.73 ± 0.80	$t=1.12$, $p>0.05$
PBS			
Before	35.57 ± 12.67	26.40 ± 14.63	$t=1.87$, $p>0.05$
After	45.00 ± 8.73	36.07 ± 14.38	$t=2.05$, $p<0.05^*$

** – Significant

Result revealed that VRBT has a significant effect on the improvement of balance score, although, the effect was not significant on manual ability score.

The level of participation, satisfaction, cooperation and motivational factors were also compared between the groups. The result revealed that all the above mentioned factors were significantly higher (participation: $p<0.02$, satisfaction: $p<0.001$, cooperation: $p<0.001$ and motivational: $p<0.001$) among the study group as compared with control group.

4. Discussion

The study result revealed a significant effect of VRBT on the improvement of balance. There were no significant difference between the study and control groups for pre-intervention mean values of balance and manual ability score. On the other hand post intervention balance score was significantly different between the groups and the value was higher for study group. These results indicate that the VR-based training in the form of Wii-Fit could improve balance of the children with cerebral palsy.

A study reported that there was an improvement in the postural ability of the children with Down syndrome by using VRBT [5].

It has been found that the Wii-Fit's balance board can improve people's balance, confidence and stability [5]. A study stated that postural control was improved after the use of Wii training with a neurological impaired adolescent for 11 training sessions [1]. The decrease in sway that was observed after training can be interpreted as a sign of increased stance stability. This finding is consistent with work by Shumway et al where massed balance training produced a decrease in center of pressure sway in children with CP [13].

It has been found that the Wii-Fit's balance board can improve people's balance and confidence [16]. The present study data also corroborate the same kind of findings where study group's levels of cooperation, motivation were significantly higher than the control group.

A study reported that there was an effective improvement in the walking and balance abilities when they used VR system in conjunction with partial body weight-supported treadmill training among post-stroke patients [18].

The possible explanation of the higher level of motivation, participation and cooperation level is, the gaming system was task. These features of training have been shown to promote behavioral changes [2] as well as neural plasticity in children [3]. Finally the multisensory feedback provided by the system may explain improvements in performance as well as learning [17]. A study stated that VR has potential benefits for children with neurological disorders and could positively affect the brain reorganization/plasticity, motor capacity, visual-perceptual skills, social participation and personal factors [14].

5. Conclusion

Results of this study showed that improvement in balance of postoperative cerebral palsy children was possible through the use of VR-based therapy in the form of Wii-Fit. It also has a significant effect on level of motivation, participation and cooperation. To the author's best knowledge, this is the first study on using this particular VR-based therapy for the rehabilitation of children with CP which need further elaboration with larger sample size.

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