Use of Virtual Reality Systems in Cerebral Palsy: Clinical Practice Guideline

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Abstract. The purpose of conducting this guide is to analyze how it affects the use of virtual reality systems in the treatment of children and adolescents suffering from cerebral palsy, in increasing its functionality. Statistically significant results are obtained concerning the improvement of postural control, balance and different aspects of progress and positive changes in upper limb function and the selective control joints. It is necessary to open new lines of research grounded in rigorous methodological quality studies, to justify adequately the use of these techniques in clinical practice.

1 Introduction

The limitations to perform functional activities in children and adolescents with cerebral palsy are important, hindering their integration into the community [1]. The use of virtual reality (VR) systems is a new treatment approach that reinforces the motor learning task oriented, providing a greater number of repetitions, lots of sensory feedback [2], increased motivation [3], [4] and commitment to therapy by the subject [5]. The objective of conducting this clinical practice guideline is to analyze what impact has the use of different virtual reality systems in the improvement and acquisition of functional skills, and assess the scientific evidence to determine what strength of recommendation are such interventions.

2 Materials and Methods

Given the novelty of the intervention in children with cerebral palsy and limited existing literature, we included all the items available, well-structured, regardless of methodology. For the literature search were consulted following databases:

J.L. Pons et al. (Eds.): *Converging Clinical & Engi. Research on NR*, BIOSYSROB 1, pp. 867–871.
DOI: 10.1007/978-3-642-34546-3_141

Pubmed (Medline), PEDro, EMBASE (OVID-Elsevier), Cochrane Library, Medline (OVID), CINAHL, ISI Web Knowledge. Criteria were established for inclusion of studies based on:

a. *Type of study:* well-structured and defined methodology.
b. *Participants:* children and / or adolescents aged 4 to 18 years with cerebral palsy, regardless of motor diagnosis and level of involvement.
c. *Intervention:* consisting of the isolated use of VR systems for training of functional skills, or inclusion of a VR system to supplement other intervention or system, assessing the performance improvement by the combined application.
d. *Outcome measures:* validated. Motor function standarized tools, gait characteristics and static balance, joint range, muscle strength, imaging techniques, etc..

Methodological quality, the level of scientific evidence and the strength of recommendations were assessed with the following tools: "Critical Review Form - Quantitative Studies and the Guidelines for Critical Review Form - Quantitative Studies" [6] and "U.S. Preventive Services Task Force "[7], as described in Table 1.

We extracted data in a standardized manner for each of the tests: sample size, age, sex, motor diagnosis, level of involvement (GMFCS), intensity of intervention, co-interventions, VR system used, outcome measures used, main results obtained.

Table 1 Methodological Quality Level of evidence and Strength of Recommendation

Ref.	Type of study	Scientific evidence level and strength of recommendations (USPSTF).	Critical Review Form – Quantitative Studies.															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Reid. 2002	Randomized control trial	I/A	1	1	1	1	1	1	1	1	0	0	0	0	1	0	1	**10**
Reid et al. 2006	Randomized control trial	I/A	1	1	1	1	1	1	1	1	0	0	1	1	1	0	1	**12**
Bryanton et al. 2006	Not randomized control trial	II-1/A	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	**14**
Reid. 2002	Single subject design.	II-3/B	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	**12**
Yu-Ping Chen et al. 2007	Single subject design.	II-3/B	1	1	1	0	1	1	1	1	0	1	0	0	1	0	1	**10**
Kott et al. 2009	Single subject design.	II-3B	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	**13**
Ching-Hsiang Shih et al. 2010	Single subject design.	II-3/B	1	1	1	0	1	1	0	1	0	0	1	1	1	0	1	**10**
Golomb et al. 2010	Single subject design.	II-3/B	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	**14**
Fluet et al. 2010	Single subject design.	II-3/B	1	1	1	0	1	1	1	1	0	0	1	1	1	0	1	**11**
Sandlund et al. 2011	Single subject design.	II-3/B	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**15**
Brien et al. 2011	Single subject design.	II-3/B	1	1	1	1	1	1	1	1	0	0	1	1	1	0	1	**12**
Sung H You et al. 2005	Case study	III/C	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	**13**
Deutsch et al., 2008	Case study	III/C	1	1	1	1	1	1	1	1	0	0	0	0	1	0	1	**10**
Cikajlo et al. 2010	Case study	III/C	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	**13**

3 Results

Only included 14 trials of 35, because the others did not satisfy the criteria for inclusion.

101 participants were recruited with any involvement topographic about the quality of tone were: 70 spastic, 1 diskinetic, 1 ataxic, hypotonic 10, 1 coreoatetosico and 12 without data, the age ranged from 4 to 18 years, the sex was distributed in 57 men / 34 women, and the level of involvement for the GMFCS ranged from I to V.

The main VR systems used were: IREX, Mandala Gesture Xtreme, PlayStation 2 (Eye Toy), Wii.

The variables studied under the condition of virtual reality were:

- 4 studies: postural control and balance in 14 participants.
- 6 studies: upper limb function in 52 participants.
- 2 studies: selective control and joint range in 17 participants.
- 3 studies: gait in 33 participants.
- 2 studies: changes in the motor cortex when performing skills of the upper limb with fMRI in 4 participants.
- 1 study: RV compared with conventional exercises of selective joint mobilization, in 16 participants.
- 3 studies: combined use of VR with other systems (treadmill, isokinetic dynamometry, robotic devices).
- 2 studies: tele-rehabilitation interventions.
- 5 studies: keep the rest of treatments (physiotherapy, occupational therapy, restrictive movement) during the intervention.

The strength of recommendation of interventions depends on the methodological quality of the studies, as shown in figure 1.

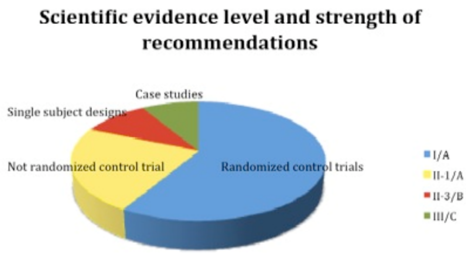

Fig. 1 Classification of studies by level of scientific evidence and strength of recommendations

Recommendations for clinical practice will depend on the level of evidence and strength of recommendation studies. Thus, Table II classifies the parameters studied high to low strength of recommendation and level of evidence, for therapeutic decision making.

We obtained significant improvements in outcome measures that assess postural control, balance and different aspects of gait. In addition, there were positive changes in upper limb function and the selective control joints.

Table 2 Main Results

SCIENTIFIC EVIDENCE LEVEL I AND STRENGTH OF RECOMENDATION A	
Positive results, not statistically significant.	Postural control in sitting.
	Upper limb function.
SCIENTIFIC EVIDENCE LEVEL II-1 AND STRENGTH OF RECOMENDATION A	
Statistically significant results.	> Active range of motion , p<0.03.
	> Time maintaining proper posture (*task-oriented activity*).
SCIENTIFIC EVIDENCE LEVEL II-3 AND STRENGTH OF RECOMENDATION B	
Positive results, not statistically significant.	Active participation of the upper limb in functional activities, coordination and quality of movement.
	1 minute gait test.
Statistically significant results.	< time taken for the upper limb movement and > path length , p=0.028 y p=0.003 respectively.
	Postural control and balance , p<0.001.
	> gait speed and stride length , p=0.02.
	Improve GMFCS dimension E, p=0.05.
	> motor performance , p=0.039.
	Resistance to the march, 6 minutes gait test.
	Refinement of coordination, timing and speed balance skills (Community Balance and Mobility Scale).
SCIENTIFIC EVIDENCE LEVEL III AND STRENGTH OF RECOMENDATION C	
Statistically significant results.	> use and quality of upper limb movement.
	> sensorimotor cortex activation , p<0.001.
	Improved balance, down 60% rolling.
	> selective movement speed (isocinetic dynamometry), p<0.05.
	More coordinated response and powerful muscle (EMG area).

4 Discussion

The scarcity of RCTs did not justify conducting a systematic review. All tests comply with the intent to treat analysis. VR systems are immersive and haptic employees, thus providing a large amount of sensory feedback and realism of the experience. There are only reports of desertion in tele-rehabilitation interventions. Numerous theories are based on Self-Efficacy and Motor Learning to justify apliacación of VR, and significant results in terms of motivation, self, pleasure and socialization of the participants, allowing them access to experiences that would otherwise be restricted for them by their accessibility or danger. There is little post-intervention assessments, making it difficult to talk about generalized learning. The RV is superior to other interventions in that it always points to a task, and therefore participants persist in the same to complete it.

5 Conclusions

Virtual reality is a promising tool for treating children with cerebral palsy. Interventions with virtual reality systems have keys to the motor training such as motivation, the intensity of therapy, varying complexity, repetition, task-oriented and multi-sensory environment. These characteristics of VR facilitate neuroplasticity, and therefore functional and adaptive changes, which are transferable to real life. This guide has some limitations due to the number of enrolled patients, its clinical variability and range of their age, as well as the methodological quality of existing trials. Although the evidence has a strength of recommendation acceptable, it is necessary to open new lines of research to justify adequately the use of these techniques in clinical practice, comparing its effectiveness in turn the benefits of other therapies.

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