Using Virtual Reality Technologies Combined with Functional Activities to Improve Upper Extremity Motor and Functional Performance

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Introduction

There is a growing trend to incorporate technology into the rehabilitation of children with upper extremity motor impairment. Virtual reality technology allows for repetitive practice of specific movement patterns while engaging the participant. Currently there is not one technology that allows a child to practice refined control of all segments of the upper extremity. Yet, children with upper extremity motor impairment have functional limitations that reflect challenges with one or a combination of the following components of upper limb control: the shoulder, elbow, forearm, wrist and/or digit control. Consequently, our intensive upper extremity neurorehabilitation program combines three virtual reality technologies, each focusing on different segments of the upper extremity. Additionally, utilizing multiple technologies allows work on graded movement, from passive to active, to meet the needs of children who require varied levels of support. We have developed an intensive upper extremity neurorehabilitation program that incorporates three virtual reality technologies combined with functional training to improve participation in daily activities.

Objectives

1. Illustrate how multiple technologies can be complimentary to each other by comprehensively training motor control of the upper extremity
2. Describe the intensive therapy model employed in this program along with the outcome measures utilized to develop individualized intervention plans and measure change over time
3. Describe the clinical advantages and challenges with using technology
4. Highlight functional outcomes achieved within our pilot program

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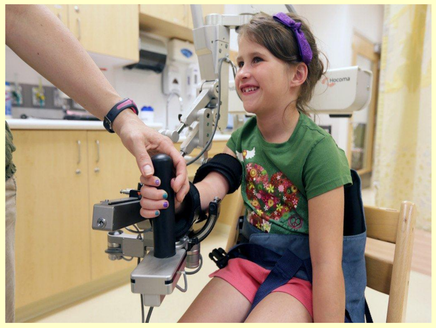
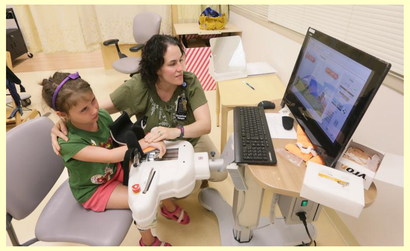
Methods

Study design	Retrospective Cohort Study
Intervention	Massed practice of upper extremity using virtual reality technologies and functional activities
Frequency	2-3 times per week
Duration	4 – 6 weeks

Total participants	N=9
Age	6 - 17 years
Gender	Male = 6; Female = 3
Macs	Level 1 – Level 3
Hemiplegia	R = 7; L = 2



The Hocoma ArmeoSpring Pediatric allows for gravity reduced movement of the upper extremity as needed to promote shoulder, elbow and forearm movement and gross grasp and release.



The Tyromotion Amadeo promotes composite or individual digit flexion and/or extension for controlled grasp and release.

The Tyromotion Pablo allows for practice of upper extremity motor movements in either multi-dimensional space or a specific plane of upper extremity movement against gravity.

Functional activities based on each client's goals involve repetitive practice for motor learning. Adaptations may be utilized as needed.

Discussion

- Using multiple technologies allows for comprehensive training of upper extremity motor control. Our technologies range from total assist for movements using robotic control to independent movement against gravity. Combined, these technologies address proximal to distal movements.
- The impairments preventing goal attainment are practiced in the virtual environment.
- The virtual environment allows the therapist to set movement parameters. Therefore a client whose movement is not functional in the physical environment can use their available range to successfully perform a task.
- Feedback from the virtual environment facilitates motor learning.
- The program addresses goals that are limited by upper extremity neuromuscular control.
- Challenges: Fit of the equipment, equipment malfunction, and potential for frustration

Conclusion and Future Direction

- Occupational therapy treatment that combines functional training with virtual reality technologies leads to improvements in functional performance.
- Future questions: 1) Which factors have the strongest influence on functional improvements following intervention (e.g. age, MACS level) and 2) Compare this intervention to traditional therapy and constraint-induced movement therapy

Results

	n	Pre Mean (SD)	Post Mean (SD)	Mean Change	p value (* Statistically significant)
COPM Performance	9	3.45 (1.5)	6.8 (1.3)	3.35	p = 0.009*
COPM Satisfaction	9	3.1 (1.4)	7.1 (1.5)	4	p = 0.002*
GAS	9	35.4 (2.3)	57 (15)	21.6	p = 0.005*
AHA (Logit score)	5	42.2 (10.8)	47 (10.5)	5.75	p = 0.001*
SHUEE (SFA %)	7	63.5 (33)	66 (31)	2.5	p = 0.4

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