Intensive therapy utilizing robotic mobility technology improves motor function post-cerebral hemispherectomy

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Introduction

Certain severe epilepsy conditions require treatment with cerebral hemispherectomy, a surgery that removes or disconnects the affected cerebral hemisphere. The procedure is effective but leaves the individual with many impairments, including hemiparesis.

Limited data exists on rehabilitative techniques after hemispherectomy, since the condition is rare and there are few analogous conditions in which an individual's bilateral motor function must rely on the remaining single corticospinal tract and cerebral hemisphere. Furthermore, data is limited on whether and how much patients can improve when beyond the acute recovery period.

We evaluated the efficacy of intensive therapy using robotic mobility technology, delivered in an enriched camp-like setting, for improving motor deficits after hemispherectomy.

Participants

Twelve post-hemispherectomy patients (15.9±3.7 years; age at hemispherectomy 6.0±4.9 years) volunteered for this study. See Table 1 for more details. There were no withdrawals. Eligibility included prior hemispherectomy, >1 year from last brain surgery, age ≥11 years, seizures well-controlled, and ability to walk at least 32 feet without another person's assistance, and ability to focus for at least 30 minutes at a time.

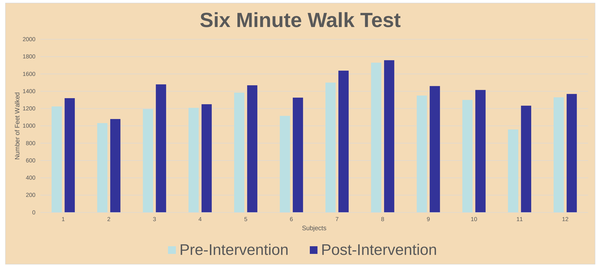
Intervention

Participants attended a rehabilitation camp for two weeks, living together in off-site affiliated housing. They participated in eight days of intensive therapy, each consisting of three hours per day of technology-assisted training (split evenly between upper and lower extremities), 15 minutes per day of range and mobilization, and three hours per day of value-added recreational activity.

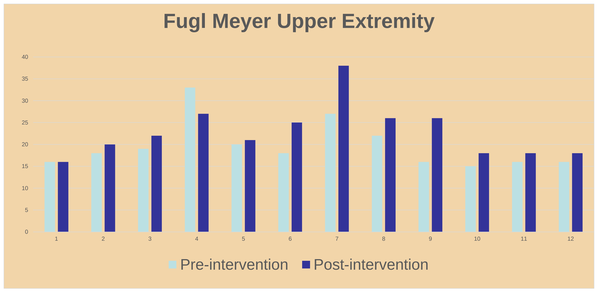
The technology-assisted training utilized Hocoma Lokomat, Hocoma ArmeoSpring, Hocoma ArmeoPower, AlterG Anti-Gravity Treadmill, and Restorative-Therapies FES Leg System; training was prescribed to target skills participants wanted to improve. Participants also received pre-camp and post-camp evaluations, orthosis evaluations, orthopedic physical therapy evaluations, activities of daily living training with occupational therapy, and social activities.

Results

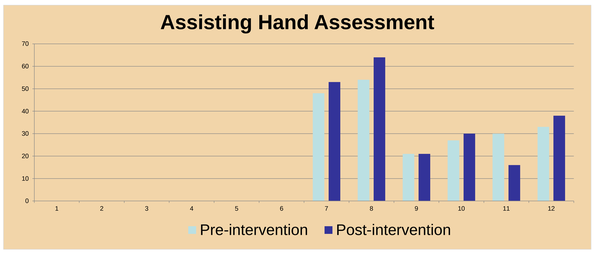
Statistically significant improvements were seen in Six Minute Walk Test, Fugl Meyer Upper Extremity, Canadian Occupational Performance Measure, and Confidence Scale, part 2. There was no statistical improvement in Assisting Hand Assessment or Confidence Scale, part 1, though clinically meaningful improvements were seen in 3 of 6 subjects who underwent AHA.



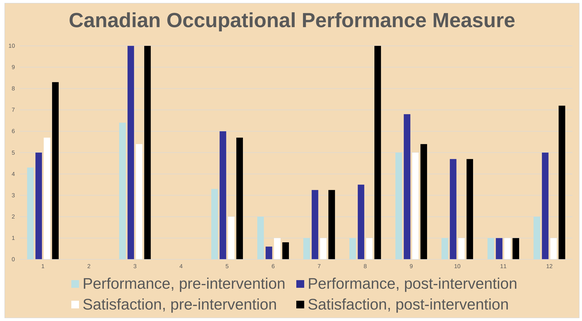
On the six minute walk test, the mean improvement was 122.4 feet (95%CI 65.6-179.2, p<0.001). The MCID for stroke population on Six-Minute Walk Test is 112.76 feet.



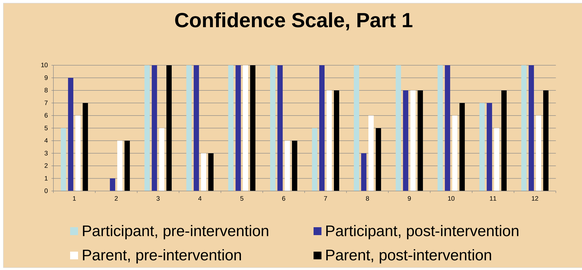
On the Fugl Meyer upper extremity, the mean improvement was 3.3 (95%CI 0.4-6.1, p=0.03).

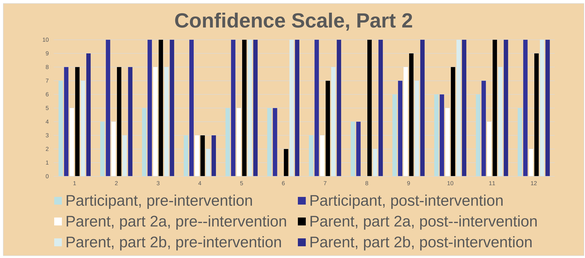


AHA was performed on six participants, with no statistically significant improvement, though a clinically meaningful improvement (≥5 logits) was seen in three subjects.



Mean improvement on COPM Performance was 1.9 (95%CI 0.7-3.1, p=0.006); on Satisfaction was 3.2 (95%CI 1.1-5.3, p=0.007); n=10.





No statistically significant difference was seen in Part 1 Confidence Scale. On Part 2, the mean improvement for Participant was 3.2 (95%CI 1.3-5.0, p=0.003), and for Parent 2a was 3.9 (95%CI 2.2-5.7, p<0.001) and for Parent 2b was 2.1 (95%CI 0.6-3.6, p=0.01).

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Table 1. Baseline characteristics of subjects

Subject	Age at Intervention (years)	Age at Hemispherectomy (years)	Gender	Hemisphere operated	Diagnosis leading to hemispherectomy	Confidence Scale activity; *Canadian Occupational Performance goals*
1	16	0.4	Female	Left	Cortical dysplasia	Hike; Run *Holding things* *Catching ball with right hand* *Putting hair up in ponytail*
2	17	0.6	Female	Left	Hemimegalencephaly	Play basketball
3	26	7	Male	Right	Rasmussen's encephalitis	Play sports without falling *Pick stuff up* *Tying shoes* *Lifting weights* *Chin ups* *Driving*
4	11	0.1	Female	Right	Hemimegalencephaly	Run
5	18	1.4	Male	Left	Cortical dysplasia	Run *Cooking* *Shaving* *Open hand*
6	14	13	Male	Right	Childhood stroke	Soccer skills *Video games* *Opening and closing hand* *Holding a cup* *Putting shoes on* *Buttons and zippers*
7	15	1.5	Male	Right	Cortical dysplasia	Play volleyball *Play Xbox with 2 hands* *Wash hair with 2 hands* *Tie shoes* *Cutting food*
8	14	5	Male	Left	Prenatal stroke	Run faster *Cutting food* *Cooking independently*
9	11.5	9.5	Male	Right	Rasmussen's encephalitis	Run; Play soccer *Fingers to move* *Incorporating left arm into everyday* *Hold terrarium with left hand* *More movement for kayaking/paddle board* *Swim with both arms*
10	16	11	Male	Right	HSV encephalitis	Run; Play soccer *Tie shoes* *Shower right side* *Cut food*
11	15	14	Male	Left	Rasmussen's encephalitis	Shovel; Garden *Work on my hand* *Video games, Xbox with right hand*
12	17	8	Male	Left	Infantile stroke	Soccer kick *Tie shoes* *Use of right arm* *Chicken chores* *Nunchuck on Wii* *Exposure to eating/cutting using right*

Conclusions

A short-duration, high-intensity regimen utilizing robotic mobility technology therapy was performed in persons who had undergone cerebral hemispherectomy at least one year ago. We found:

- Improvement in walking endurance, upper extremity function, individual perceived occupational performance, and physical activity confidence.
- Therapy elicited functional improvements after just eight days of training in the first regimen of therapy.
- Therapy elicited improvements even though participants were out of the acute recovery period after their hemispherectomy surgery.

Future investigations include identification of optimal therapy candidates (baseline performance, chronicity, underlying etiology), and analysis of changes in stride characteristics.