Changes in Hand Function After Three-weeks of Training Using a Novel Passive Device

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Background

- Persons with Stroke (PWS) can acquire significant impairment and disability to the hand (Gillen 2015).
- Hand and upper limb recovery in the chronic stage of stroke is attributable to changes in plasticity (Nudo 2003).
- In this study, a novel and passive hand function training (HFT) device (MyHand™ System) was used to train hand function in individuals with chronic stroke.
- The objective of this study was to estimate differences in functional changes of the upper limb, primarily the hand, in persons with chronic post-stroke upper limb hemiparesis, as a result of a 3-week HFT program using the MyHand™ System.
- *This project was divided into 2 main sections that will be published separately; a functional component and a transcranial magnetic stimulation (TMS) component.*

Methods

- Eleven subjects who sustained stroke ≥6 months prior to the start of the study were recruited.
- Subjects with stroke were included or excluded in the study as per the following criteria:

INCLUSION CRITERIA

- Ages 18-100
- Chedoke McMaster Stroke Assessment (CMSA) Score for the hand and shoulder pain ≥ 3
- Mini-Mental State Exam (MMSE) Score ≥24

EXCLUSION CRITERIA

- Botox injection in the upper limb within three months of study commencement
- Severe contractures impacting hand function
- Any type of other severe neurological or musculoskeletal conditions that impairs sensory motor function of the hand

Experimental Protocol

- All participants were trained for 1-hour/session, on pincer, tripod, quadripod and spherical grasp finger strengthening/coordination exercises using the MyHand™ System 5 times/week for 3 weeks.
- Participants were assessed prior to start of study, and on completion of the HFT programme.
- Primary functional outcome measure: Action Research Arm Test (ARAT),
- Secondary functional outcome measures: Box and Block Test (BBT), ABILHAND questionnaire, goniometric (Wrist and Hand) and Dynamometric (Grip and Pinch) Measures.

Device Information

Figure 1 MyHand™ System MK 2.4.5

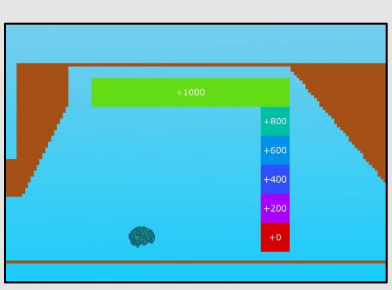

Figure 2: The visual feedback the participant is viewing while using the MyHand™ System. One is advised through flexing and extending each finger to guide the brain through the course while avoiding the brown blocks.

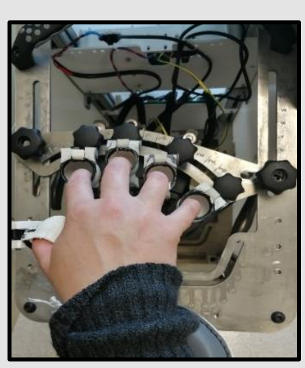

Figure 3: How the hand is placed in the MyHand™ System. Each Finger is placed in separate finger cups and adjusted accordingly

Results

- All participants completed at least 13 of the 15 training sessions over 3-weeks, and the pre and post assessment sessions.
- The Wilcoxon signed rank test was used to examine within-subject changes in functional outcome measures and statistical significance was set to p≤0.05 for all variables.

Assessment	PRE	POST	Change	P – value
ARAT – Grasp	6.55±7.27	8.36±7.76	1.82±2.27	0.009*
ARAT – Grip	3.72±4.08	5.55±5.15	1.82±1.83	0.010*
ARAT – Pinch	4.18±5.11	6.91±6.80	2.73±2.57	0.006*
ARAT – Gross Mvmt	4.91±2.51	5.45±2.54	0.55±0.82	0.032*
ARAT - Total	19.36±18.63	26.27±21.75	6.91±5.80	0.004*
BBT	6.55±9.97	10.18±13.93	3.63±5.27	0.023*
ABILHAND	0.58±1.09	0.95±1.07	0.37±0.92	0.078

Table 1: Results of the functional assessments - All values are presented as Mean ± SD. * denotes statistical significance

- All objective functional outcome measures showed statistical significance (table 1).
- ARAT and ABILHAND surpassed the minimal clinically important difference (MCID) criteria of 5.7 and 0.26-0.35.

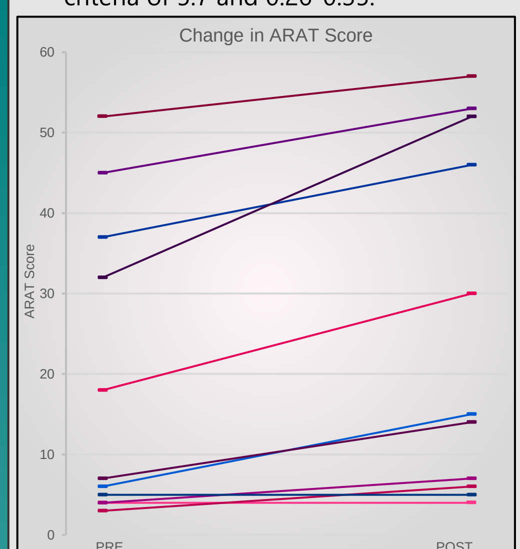

Figure 4: Changes in each participant's ARAT score pre and post intervention.

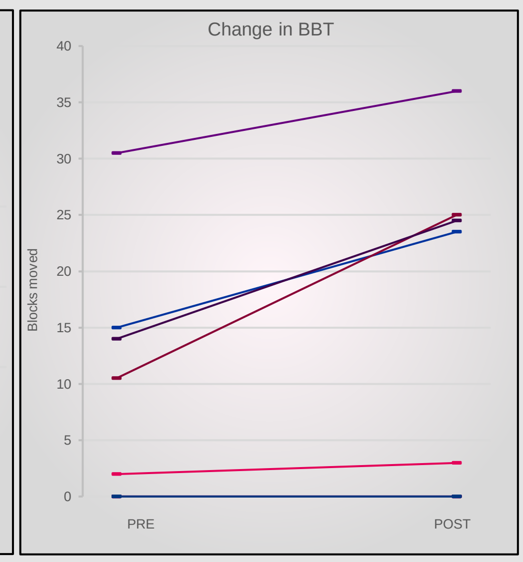

Figure 5: Changes in each participant's BBT score pre and post intervention.

Discussion/Conclusion

- The most fundamental mechanisms that mediate recovery and/or stimulate plasticity as a result of targeted training in individuals' post-stroke has been attributed to changes in muscle synergies (Cheung et al., 2009).
- Results from this study indicate significant differences in hand function when assessed for gross and fine motor tasks consequent to a 3-week targeted HFT programme. Evidence presented here is consistent with those presented in the literature with robotic interventions (Orihuela-Espina et al. 2015, Saleh et al. 2017).
- Results from this study indicate patient-driven, passive hand function therapy has a strong potential to elicit a positive change in upper limb activity and manual dexterity in PWS experiencing hand function disability.
- Further studies should investigate using a larger sample to better understand the benefits of passive HFT and make informed recommendations for transfer to clinical practice.
- Future studies could also investigate whether passive devices have the potential to reduce spasticity when compared to other technology and continue to explore its efficacy in restoring motor control and functional ability.

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