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PARTICIPANT: 24 year old male with right unilateral frontotemporal hemorrhagic stroke

APPROACH: Walking with Keeogo and movement based therapy was used to increase intensity of treatment and then mobility and quality of movement. This was done to improve walking speed, gait quality, coordination of movements, and to decrease dependence on assistive devices.

RATIONALE: For greater immediacy of a high volume of gait training we employed an approach supplemented by the Keeogo lightweight exoskeleton. Robotic assisted gait training in combination with movement based therapy was applied to address improving quality of walking, posture, and motor control. The device is motorized at the knee, here settings were customized to promote flexion and support the leg in stance. We explored a volume and intensity of movement that would otherwise have been difficult given participants atypical movement patterns.

History

24 year old male had a hemorrhagic stroke, a ruptured arteriovenous malformation (AVM), in the right frontotemporal region (July 2017). It was addressed acutely with a decompressive craniectomy and AVM resection. They remained in acute care for 3 months followed by 6 weeks of acquired brain injury (ABI) inpatient rehabilitation. At the point of discharge from the Toronto Rehabilitation Institute, November 27, 2017, they were able to ambulate for 10-15 meters. They were then in outpatient rehabilitation at the Toronto Rehabilitation Institute for another 5 weeks (5x/week). Training began at Propel Physiotherapy 1s/week on January 10, 2018 while continuing 2x/per week at the Toronto Rehabilitation Institute day hospital. In January he was walking using a 4 pt cane with 1-person assist. In treatment, again with the assistance of 2 people, they were able to tolerate body weight supported treadmill training BWSTT (1 at trunk and 1 on left foot to ensure heel strike and foot clearance) for 15 minutes at 1.6 km/h. Hip and knee flexion were limited during swing phase of gait and there was a pronounced deficit in ability to shift on the left leg during stance. Treatment with normal movement therapy (Bobath) with a focus on sensory feedback and pregait which incorporated BWSTT was conducted from Jan 10 to Feb 21, 2018 (1x/week for 7 weeks).

Introduction

The first fitting and familiarization with the Keeogo exoskeleton occurred on April 9, 2018. 14 training sessions with Keeogo over the course of 6 weeks began May 7, 2018 . 41 sessions of movement based therapy over the course of 23 weeks began July 20, 2018. Robotic assisted gait training (RAGT) with the Keeogo exoskeleton began 8 months post-stroke: RAGT comprised of 90 minute sessions, 3x/week, for a total of 6 weeks. General mobility, walking speed and number of steps were assessed by functional tests before RAGT (T_0), after 6 weeks of RAGT training (T_1), and at the 6 month mark after continued movement based therapy (T_2).

A

	TUG	10 MWT
T_0	Apr 9 2018	May 10 2018
T_1	Jun 12 2018	Jun 12 2018
T_2	Nov 30 2018	Dec 7 2019

B

T_0 $\xrightarrow[\text{6 weeks}]{\text{Keeogo Training}}$ T_1 $\xrightarrow[\text{5 months}]{\text{Functional Movement Therapy}}$ T_2
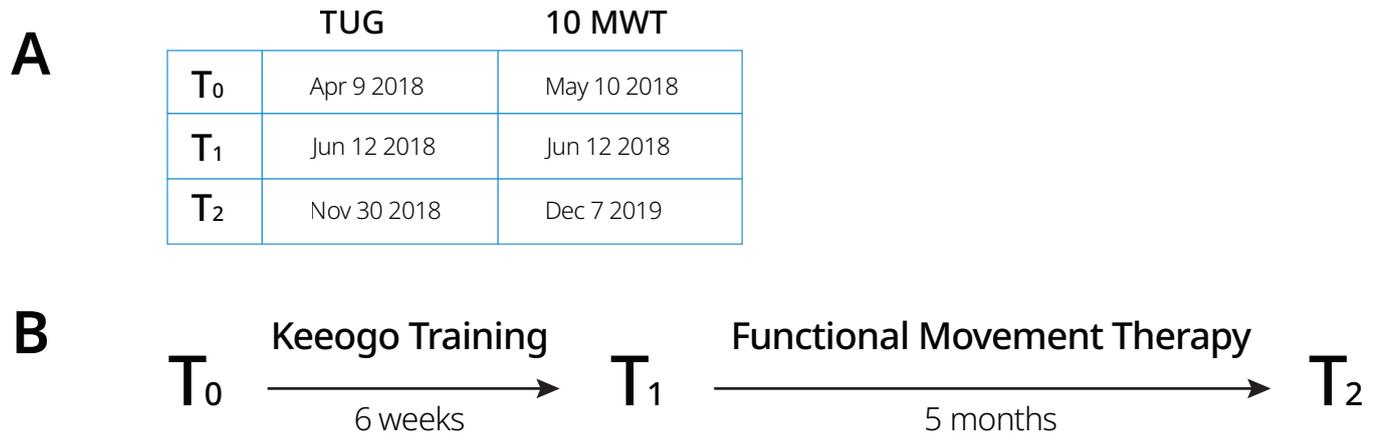
Fig. 1 Time course of functional testing and outpatient therapy. A) Date of functional testing - the timed up and go (TUG) and 10 meter walk test (10MWT). **B)** Timeline of treatment plan with indication for time points where functional tests were conducted.

Results

Timed functional tests and walking speed improved (improvement of almost 2x at each of T_1 and T_2 relative to initial testing at T_0. Improvement in gait quality was observable with a reduction in atypical patterns; the stance time, weight shifting, hip extension and swing of the left leg improved. This is while the use of support from assistive devices decreased, from the initial use of a 4-point cane to use of a trekking pole. Some carryover effects after RAGT was observable, with more equal stride lengths and better acceptance of weight on the affected limb. We combined Keeogo with normal movement based therapy to improve the endurance, speed and quality of walking, while working towards the goals of improving walking and decreasing their dependence on walking aids.

A

	Assistive Device	TUG (s)	Self Selected Pace 10 MWT (m/s)	Self Selected Pace 10 MWT (steps)	Fast Pace 10 MWT (m/s)	Fast Pace 10 MWT (steps)
T_0	4-point cane (R), Hinged AFO (L)	63	0.16	17.25	0.22	14.7
T_1	Treking Pole (R), Hinged AFO (L)	30	0.33	13	0.52	10.5
T_2	Treking Pole (R), Hinged AFO (L), Knee Brace (L)	17.7	0.6	12	0.81	10
T_2	Hinged AFO (L), Knee Brace (L)	21.1				

Fig 2. Functional testing before, during, and after treatment. Timed functional tests (Timed up and go, TUG and 10 Meter walk test, 10MWT) recorded at points throughout treatment (T_0, T_1, T_2). Assistive devices used by participant are indicated as well as speed during the 10MWT. 10MWT was conducted under two conditions, one where the participant performed the task at a self selected speed and another where they were instructed to complete the tasks as quickly as possible without compromising safety.