The effect of robotic assisted gait training for children with neuromotor disorders in a clinical setting: a case series

Ann Flanagan, PT, PCS[1]; Shubhra Mukherjee, MD[1]; Michelle Urban, PT, MHS, WCC[1]; Kathleen Sweeney, PT, DPT, PCS[1] ;Brittany Prero PT, DPT[1] ; & Nicole Viverito, PT, DPT[1]
[1]Shriners Hospitals for Children, Chicago, IL

Shriners Hospitals for Children™

INTRODUCTION

- Children with neuromotor disorders often demonstrate impairments in posture, strength, and gait efficiency.
- Robotic assisted gait training (RAGT) used partial bodyweight support treadmill training and a robotic exoskeleton to improve gait and endurance by providing highly intense and repeatable partially assisted steps during a treatment session.
- Robotic training is often used in a research setting and less often as a clinical tool.

OBJECTIVES:

1. To describe how RAGT was integrated into the physical therapy management of children with neuromotor disorders.
2. To evaluate the individual changes in measures of body structure/function, activity and health related quality of life (HRQOL) after a series of RAGT sessions.

METHODS

Participants: 4 patients, Gross Motor Function Classification (GMFCS) Scale II-III (1F/3M, age 11.5±1.7 yrs) with a variety of neuromotor disorders (CP, transverse myelitis, post brain tumor resection) participated in minimum of 9 RAGT sessions.

Measures:

- Daily logs for each session
- Lower extremity ROM and hand held dynamometry
- Gross Motor Function Measure (GMFM) dimensions D (stand) and E (walk/run/jump)
- 6 minute walk test (6MWT)
- Gait Outcomes Assessment List (GOAL) parent report

RESULTS

- Training sessions of 20-60 min with actual stepping time of 15-33 min per session with increasing speeds and decreasing body weight support were documented (Table 1).
- Total mileage ranged 1.7-20.5 mi, with average miles per session of 0.2-0.9 mi
- Mild improvements in ROM and strength were seen for some patients and 1 patient was able to advance endurance with a walker while 2 patients significantly increased on the 6MWT, and minimum clinically important differences for GMFM were met for 75% of patients. Overall scores on the GOAL as well as many of the dimensions increased after training (Table 2).

Table 1: Summary of treatment logs

Parameter	Subject 1	Subject 2	Subject 3	Subject 4
Total weeks of training	11	13	2	6
Total number of sessions	13	22	9	14
Walking time				
Range of training times (minutes)	45 to 60	60 to 77	6 to 23	2 to 35
Walking minutes average per session	21.3	33.4	15.5	22.2
Walking minutes range per session	11 to 35	20 to 42	6 to 23	2 to 35
Walking minutes total for encounter	277	701	139	312
Walking hours total for encounter	4.6	11.7	2.3	5.2
Mileage				
Average distance walked per session (ft)	1841	4913	978	1056
Mileage distance range per session(ft)	663 to 2986	1441 to 5583	167 to 1946	13 to 1932
Total distance walked during encounter (miles)	4.5	20.5	1.7	2.8
Average miles walked per session	0.35	0.93	0.2	0.2
Speed				
Initial speed average (mph)	0.8	1.2	0.2	0.5
Initial speed range (mph)	0.3-1.2	0.5 to 1.6	0.1 to 0.2	0.3 to 0.7
Peak speed average (mph)	1.1	1.3	0.5	0.5
Peak speed range (mph)	0.9-1.2	1.0 to 1.6	0.5 to 1.0	0.1 to 0.8
Percent body weight				
Average percent body weight for encounter	63.9%	87.9%	30.7%	28.7%
Range % body weight for encounter	48 to 79%	47 to 95%	20 to 52%	6 to 66%

CONCLUSIONS

- Using weekly or intensive outpatient scheduling, the primary objective of integrating RAGT into the clinical management for children with neuromotor disorders was met.
- Total time, mileage and speed of walking were greater than that of land-based sessions and intensive gait training was provided.
- Notable improvements in activity and health related quality of life were seen and patients reported greater endurance, fluidity and confidence at the end of the training.
- Each session needed to be individualized to the child's fatigue, motivation and ability level.

Table 2: Summary of outcomes pre and post therapy

Outcomes	Subject 1 pre-therapy	Subject 1 post-therapy	Subject 1 change score	Subject 2 pre-therapy	Subject 2 post-therapy	Subject 2 change score	Subject 3 pre-therapy	Subject 3 post-therapy	Subject 3 change score	Subject 4 pre-therapy	Subject 4 post-therapy	Subject 4 change score
Activity level												
FMS at 5m, 50m, 500m	2,1,1	2,1,1	none	5,2,2	5,2,2	none	5,5,5	5,5,5	none	4,1,1	4,2,1	level at 50m
6 MWT (ft)	411	376	↓35	1048	1215	*↑167	558	530	↓28	648	1135	*↑487
GMFM-88 D standing (max 100%)	51.3%	71.8%	*↑20.5%	87.2%	94.9%	*↑7.7%	76.9%	84.6%	*↑7.7%	66.7%	66.7%	0.0%
GMFM-88 E walking, running, jumping (max 100%)	16.7%	23.6%	*↑6.9%	87.5%	91.7%	*↑4.2%	54.2%	54.2%	0.0%	41.7%	43.1%	*↑1.4%
Health related quality of life: Parent reported GOAL												
ADLs & independence	33.3	48.2	↑14.9	96.3	100.0	↑3.7	56.8	64.2	↑7.4	56.8	55.6	↓1.2
Gait & mobility	23.0	29.0	↑6.0	52.0	55.0	↑3.0	33.0	64.0	↑31.0	29.0	53.0	↑24.0
Pain, discomfort, fatigue	63.3	71.4	↑8.1	89.9	95.9	↑6.0	89.9	89.9	0.0	83.7	83.7	0.0
Physical activities, sports & recreation	14.6	20.8	↑6.2	39.6	52.8	↑13.2	33.3	27.1	↓6.2	20.8	27.8	↑7.0
Gait pattern & appearance	38.9	41.7	↑2.8	52.8	41.7	↓11.1	30.6	61.1	↑30.5	36.1	44.4	↑8.3
Use of braces & mobility aids	33.3	50.0	↑16.7	75.0	50.0	↓25.0	0.0	33.3	↑33.3	0.0	50.0	↑50.0
Body image & self-esteem	66.7	54.2	↓12.5	50.0	41.7	↓8.3	33.3	45.8	↑12.5	33.3	50.0	↑16.7
Standardized total score	37.3	43.2	↑5.9	64.8	65.7	↑0.9	45.6	57.2	↑11.6	40.2	53.2	↑13.0

Abbreviations: FMS = Functional Mobility Scale; 6MWT = 6 minute walk test; GMFM = Gross Motor Function Measure; GOAL = Gait Outcomes Assessment List

* Denotes improvement greater than or equal in range to minimum clinically important differences (MCID) published in literature for children with cerebral palsy and/or aquired brain injury (Storm et al. 2020)