Project Title

Effect of intensive robotic exoskeleton gait training on functional outcomes and energy expenditure in patients with neurological conditions

Project Lead and Members

Project lead: Amelia Ho Chiu Yi

Project members: Ong Cheng Hong, Charissa Tan Si Lei, Wee Seng Kwee

Organisation(s) Involved

Tan Tock Seng Hospital, Rehabilitation Centre

Healthcare Family Group Involved in this Project

Allied Health

Specialty or Discipline (if applicable)

Physiotherapy

Project Period

Start date: May 2019

Completed date: March 2021

Aims

This study aims to evaluate the effect of intensive robotic exoskeleton gait training on trunk control, balance, gait speed, endurance and energy expenditure of walking.

Background

Powered robotic exoskeleton is a relatively new technology in the field of rehabilitation. Having the ability to provide highly repetitive and intensive gait training, this therapeutic approach aims to maximize neural recovery, motor learning and motor control.

Methods

Case series report on 23 patients admitted to TTSH Rehabilitation Centre who had undergone intensive gait training using the EksoGT exoskeleton: fourteen with stroke, five with spinal cord injury, three with traumatic brain injury, and one with multiple sclerosis.

Balance, gait speed, endurance, trunk control and energy expenditure were evaluated using Berg Balance Scale (BBS), ten-metre walk test(10MWT), six-minute walk test (6MWT), Trunk Impairment Scale (TIS) and Physiological Cost Index (PCI) respectively. Wilcoxon signed rank test was used for statistical analysis.

Inclusion criteria: Weight less than 100kg, ability to follow at least 2 step commands

Exclusion criteria: Severe osteoporosis, unhealed fractures, severe hip/knee/ankle contractures, open skin lesions in legs or trunk

Results

Statistically significant improvements in BBS($p<0.001$), TIS ($p<0.001$), 6MWT ($p<0.001$) and PCI ($p<0.05$), but not 10MWT ($p=0.126$) was observed after EksoGT training. Subgroup analysis of patients ambulating with at least minimal assistance revealed statistically significant improvements in gait speed ($p<0.05$).

Additionally, nine patients achieved the minimal detectable change (MDC) of at least six points for BBS, two achieved the minimal clinically important difference (MCID) of 0.16 meters per second for 10MWT, seven achieved the MCID of34.4 meters for 6MWT, and seven achieved the MDC of at least 0.52 beats per metre for PCI post EksoGT training. Ten patients demonstrated more than 50 percent improvement in energy expenditure.

Lessons Learnt

Exoskeleton training is a relatively new technology that can be incorporated with conventional Physiotherapy to provide patients with the experience of normal physiological walking. Embracing advancements in technology would equip clinicians with additional skillsets in improving patient care and thus lead to better patient outcomes.

Conclusion

Exoskeleton training can lead to significant improvements in balance, trunk control, and endurance, resulting in significant reduction in energy expenditure of walking.

Additional Information

One of the challenges faced was the hiatus in Outpatient services due to Covid-19 restrictions, resulting in the small sample size of patients included in the study.

Note: Singapore Health & Biomedical Congress (SHBC) 2021 – Merit award (Category: Singapore Allied Health Award)

Project Category

Technology, MedTech, Robotics

Keywords

Simulation Training Robots, Assistive Robots, Exoskeleton Gait Training, Energy Expenditure

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SG-AH-02

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The median score with the interquartile range are reported in Table 1 below:

Table 1: Outcome measures pre and post EksoGT training
Data are presented as median (interquartile range)

	Pre	Post	Difference between pre and post EksoGT training		
			Z-value	*p*-value	Effect size
PCI	1.71 (0.763 – 4.17)	1.21 (0.450 – 3.29)	2.32	0.020*	0.350
TIS	11 (2 – 15)	16 (12 – 18)	3.83	0.000*	0.565
BBS	6 (4 – 27)	11 (5 – 37)	3.73	0.000*	0.540
FIM locomotion	3 (1 – 4)	4 (2 – 5)	3.76	0.000*	0.554
FIM transfer	4 (3 – 4)	4 (4 – 6)	3.36	0.001*	0.495
10MWT	0.133 (0.720 – 0.242)	0.164 (0.800 – 0.315)	1.53	0.126	0.236
6MWT	0 (0 - 45)	56 (25 – 87)	4.11	0.000*	0.605

Key: PCI: Physiological Cost Index; TIS: Trunk Impairment Scale; BBS: Berg Balance Scale; FIM: Functional Independence Measure; 10MWT: 10-metre walk test; 6MWT: 6-minute walk test; *: p<0.05.

DISCUSSION & CONCLUSION

Exoskeleton training can lead to significant improvements in balance, trunk control, and endurance, resulting in significant reduction in energy expenditure of walking.