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The study on effects of training with a soft wearable robot (Myosuit®) on walking ability for chronic stroke patients

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Introduction

- Stroke is the primary cause of adult neurological disability.
- Ability to walk is the goal most often requested by stroke patients.
- Robotic exoskeletons have shown to be able to provide more intensive patient training, better quantitative feedback and improve functional outcomes.
- Soft wearable robots, which are lightweight and comfortable, allow active participation of the patient while enabling faster and efficient gait.

Methods

- **Design**

- Randomized controlled trial conducted from April 2022 to September 2022
- 30 patients randomly assigned to Myosuit® group or control group

- **Inclusion criteria**

- Hemiparetic patients over 19 years old
- Functional ambulatory category scale between 2 and 4

- **Exclusion criteria**

- Patients who are not fit to the device in terms of height, weight, and excessive spasticity
- Patients who are not able to ambulate due to medical or musculoskeletal condition

- **Myosuit ®**

- Soft wearable exoskeleton robot developed to actively assist hip and knee extension (Figure 1)

Fig1. Myosuit®, a wearable exoskeleton robot developed by MyoSwiss AG

- **Training session**

- 10 training sessions within 5 weeks
- 5 minutes warmup, 40 minutes of main training and 5 minutes of cooldown exercise
- Main training comprised of 3 sets of either walking or balance protocol

- **Outcomes**

- 10-meter walking test (10MW), Motricity index of the lower extremities (MI), Berg balance scale (BBS), Timed Up and Go (TUG), 6-minute walking test(6mWT)
- Gait analysis training system to evaluate kinematic and kinetic gait parameters

Results

Table 1. Baseline characteristics

Characteristics	Myosuit®	Control	P-value
Patient number	15	15	0.157
Age (years)	63.7±6.5	66.7±4.9	0.157
Weight (kg)	65.2 (10.4)	65.7 (13.2)	0.903
Height (cm)	164.5 (8.7)	163.3 (9.4)	0.733
Stroke etiology			0.71
Hemorrhagic	7	5	
Infarction	8	10	
Years from onset	19.9 (7.5)	17.0 (6.7)	0.274
Baseline FAC			0.763
2	1	2	
3	4	5	
4	10	8	

*Values are presented as mean±SD

Table 2. Changes in gait function, balance ability and gait parameters from baseline and after training

	Myosuit® (n=15)			Control (n=15)			P-value for group difference
	Pre-training	Post-training	P-value	Pre-training	Post-training	P-value	
10MW[a] (m/s)	0.72 (0.31)	0.85 (0.38)	0.018*	0.70 (0.30)	0.81 (0.28)	0.046*	0.813
MI[a]	62.2 (11.9)	64.1 (11.4)	0.062	59.1 (10.6)	60.9 (10.8)	0.020*	1.000
BBS[a]	44.9 (6.4)	48.0 (7.2)	0.001*	45.2 (7.6)	49.4 (3.6)	0.021*	0.529
TUG[a] (sec)	19.6 (11.9)	16.5 (6.2)	0.119	19.8 (6.9)	17.4 (6.0)	0.054	0.745
6mWT[a] (m)	263.7 (105.3)	275.1 (103.7)	0.126	252.2 (93.2)	279.6 (96.3)	0.015*	0.199
V_{intact}[a,c] (m/s)	0.65 (0.27)	0.82 (0.27)	0.006*	0.76 (0.31)	0.88 (0.21)	0.061	0.644
$V_{affected}$[a,c] (m/s)	0.64 (0.31)	0.70 (0.32)	0.354	0.67 (0.50)	0.53 (0.36)	0.298	0.178
$SLSP_{intact}$[b,d] (%)	40.0 [37.4, 49.2]	41.5 [37.3, 44.0]	0.561	38.3 [34.2, 40.8]	40.8 [35.6, 44.0]	0.847	0.787
$SLSP_{affected}$[b,d] (%)	37.5 [32.6, 38.2]	34.4 [32.4, 37.2]	0.229	35.3 [31.9, 37.0]	35.0 [33.3, 36.7]	1.000	0.633

[a] Values are presented as mean±SD
[b] Values are presented as median [IQR]
[c] Velocity of intact/affected limb
[d] Single limb support phase of intact/affected limb

Table 3. Training effects on patients with better ambulation ability (FAC 4)

	Myosuit® (n=15)			Control (n=15)			P-value for group difference
	Pre-training	Post-training	P-value	Pre-training	Post-training	P-value	
10MW[a] (m/s)	0.82 (0.33)	0.96 (0.41)	0.0433*	0.88 (0.31)	0.96 (0.23)	0.245	0.605
MI[a]	65.4 (10.6)	67.1 (10.3)	0.2061	59.6 (8.3)	62.4 (8.2)	0.0342*	0.542
BBS[a]	47.9 (4.9)	50.7 (4.4)	0.0002*	49.6 (3.2)	50.9 (3.3)	0.2857	0.176
TUG[a] (sec)	18.1 (14.5)	14.3 (6.1)	0.2134	16.2 (6.6)	13.2 (2.8)	0.1932	0.841
6mWT[a] (m)	294.8 (114.9)	312.1 (105.6)	0.0993	312.5 (77.5)	335.5 (76.2)	0.1167	0.719
V_{intact}[a,c] (m/s)	0.66 (0.29)	0.87 (0.30)	0.0153*	0.90 (0.34)	1.00 (0.15)	0.3885	0.424
$V_{affected}$[a,c] (m/s)	0.72 (0.34)	0.81 (0.34)	0.2099	0.93 (0.58)	0.65 (0.43)	0.2511	0.098
$SLSP_{intact}$[b,d] (%)	48.7 [40.1, 50.7]	42.2 [39.6, 48.4]	0.4922	39.5 [34.9, 44.6]	37.2 [34.8, 43.1]	0.3125	0.859
$SLSP_{affected}$[b,d] (%)	38.1 [32.8, 38.2]	35.3 [32.8, 36.7]	0.625	35.4 [33.6, 36.6]	34.9 [33.4, 35.9]	0.5469	0.722

[a] Values are presented as mean±SD
[b] Values are presented as median [IQR]
[c] Velocity of intact/affected limb
[d] Single limb support phase of intact/affected limb

- Myosuit® group and the control group patients all showed some progress in outcome. measures, but the gait parameters before and after the training was not significantly different (Table 2).
- Subgroup analysis of FAC 4 patients showed significant improvements in 10-meter walking test, Berg balance scale, and gait velocity of the intact limb (Table 3).

Discussion

- All groups benefited from training regardless of Myosuit® use.
- Patients with relatively spared ambulation function showed better response to Myosuit® training.
- Myosuit® training is feasible and safe to utilize.
- Future directions
  - Study on more patients
  - Evaluate Myosuit® training in acute and subacute patients

Conclusion

- This study showed that gait training using Myosuit®, a soft exoskeleton type robot, was effective in improving gait function in patients with relatively spared gait function.