

The muscle activity by robot-assisted gait training methods in children with brain injury; a pilot test

So Ra Park¹⁾, Eun Kyeong Lee¹⁾, Ji Hye Jung²⁾, Hyun-Kyung Kim²⁾

1) Department of Rehabilitation & Assistive Technology,

2) Department of Rehabilitation Medicine,

National Rehabilitation Center, 58 Samgaksan-ro, Seoul, Republic of Korea, 01022

Objective

- Robot-assisted gait training(RAGT) effectively improves gait functions through high-intensity, high-repetition training. However, research on training methods that can heighten clinical effects while considering the characteristics of robots has not been conducted extensively.
- The aim of this study is to examine the changes in exercise intensity and muscle activity for different training parameter values of robots when walking robots (Lokomat Pro[®], Hocoma, Switzerland) are applied to children with brain injury.

Materials and Methods

- Robot-assisted gait training(40 min/session, a total of 20 sessions) was performed for children with gait disturbances caused by brain injury.
- Training method
 1. **Fixed parameter** over 20 session
 - Walking speed
 - : children feel comfortable
 - BWS(body weight support)
 - : body alignment is maintained
 2. **Adjusted parameter** over 20 session
 - GF(guidance force)
 - : decreased by 5% from 100% to observe the changes in exercise intensity and muscle activity
- Measurement method
 1. **Exercise intensity**
 - Kavonen formula based on the heart rate (WristOx2 model 3150[®], NONIN, U.S.A.)
 - Borg Rating of Perceived Exertion(RPE) from 6 to 20
 2. **Muscle activity** of the lower extremity
 - Amplitude using a surface EMG device (Trigno Wireless EMG[®], Delsys, U.S.A.)

Results

- Two children with cerebral palsy (Child 1: 10 years old, female, GMFCS III; Child 2: 13 years old, male, GMFCS III) participated in this study.
- The average exercise intensity using heart rate and the RPE of the children tended to increase with decreasing GF(Table 1).

Table 1. The changes of exercise intensity by training mode of robot-assisted gait training

Session	Child 1			Child 2			
	GF(%)	Exercise Intensity		Session	GF(%)	Exercise Intensity	
		Using HR(%) ^{a)}	RPE			Using HR(%) ^{a)}	RPE
1, 2	100	20.7	15	1-5	100	15.8	10
3, 4	95	22.5	13	6-9	95	20.5	11.6
5, 6	90	25	14	10-12	90	15.2	12.3
7-12	85	26.5	13.5	13-15	85	21.3	12
13-18	80	26.8	13.8	16, 17	80	16.4	11
19	75	28.4	13	18, 19	75	18.8	11.5
20	70	28.1	16	20	70	20.3	11

^{a)} Exercise intensity based on Kavonen formula(%) = ((HR during training-HR rest)/((HR max-HR rest)) × 100

- Both children experienced an increase in the muscle activity of both legs as the GF decreased.
- The muscle activities of the extensor muscles (G. maximus, G. medius, V. medialis) and flexor muscles (Biceps femoris, Tibialis anterior) increased during the stance and swing phases of walking, respectively(Figure 1, 2).

Figure 1. sEMG patterns of child 1

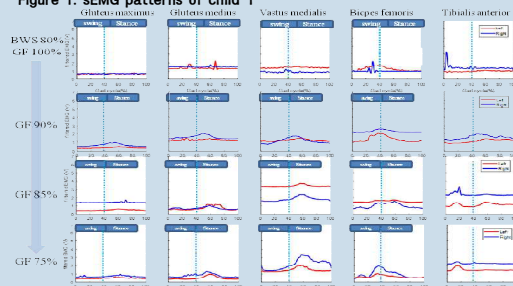
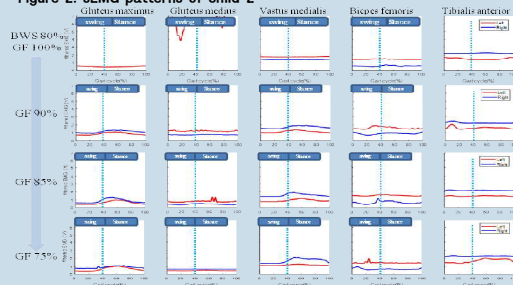


Figure 2. sEMG patterns of child 2



- Both children experienced increased gross motor function and decreased muscle tone after RAGT, in which Child 2 particularly experienced improved gait ability(Table 2).

Table 2. Clinical evaluation after robot-assisted gait training

	Child 1		Child 2	
	Pre	Post	Pre	Post
10m walking test(sec)	N/T	N/T	N/T	482
6minute walking test(m)	N/T	N/T	N/T	22.1
MAS	2	1.5	2	1.5
GMFM-66 (95% confidence interval)	45.14 (43.08 -47.20)	46.09 (44.03 -48.15)	39.73 (37.32 -42.14)	43.79 (41.73 -45.85)

N/T: not testable, MAS : Modified Ashworth Scale, GMFM-66: Gross Motor Function Measure-66

Conclusion

- When gait training is performed using Lokomat Pro on children, exercise intensity and muscle activity increase with a decrease in GF. This implies that the clinical effects of robots can be improved by adjusting training parameters.
- Further studies should be conducted to develop training methods for robots by investigating neurophysiological changes in parameters, such as exercise intensity and muscle activity, with respect to parameter combinations of robots.