STEPPING-OVER GAIT CHARACTERISTICS IN CHILDREN WITH DOWN SYNDROME

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INTRODUCTION

Approximately 80% of children with DS exhibit difficulty in walking [1]. Most studies on gait characteristics in children with DS have concentrated on level walking. We are not aware of any study dealing with stepping over obstacles, despite the frequency with which this must be done in everyday life and the potential consequences of falls [2]. The purpose of this study was to investigate the step-over gait characteristics of children with Down syndrome (DS) as they approached and stepped over obstacles of different heights. We tested the null hypothesis that no differences exist in dependant variables when stepping over obstacles of different heights.

METHODS

Thirteen boys with DS initially participated in this study but analysis has been completed for only five (age: 12.0 ± 0.9 yrs; height: 134.9 ± 9.7 cm; mass: 34.4 ± 8.4 kg) of them due to difficulties in obstacle clearance. A 10.0 m x 1.3 m walkway with a firm dark surface was used for data collection. An AMTI force plate was embedded in the walkway such that the first footfall after obstacle clearance occurred on the force plate. Three-dimensional motion analyses and ground reaction force analyses were performed to obtain dependant variables. One-way repeated-measure ANOVA was performed to determine whether obstacle height had a significant effect on the dependent variables. Four levels of obstacle height were used: 0, 2.5, 5.2, and 15.2 cm [1].

RESULTS AND DISCUSSION

As obstacle height increased, the subjects exhibited greater vertical foot clearance, obstacle to heel horizontal distance, hip sway angle, joint ROM (knee & hip), impulse, 1st peak force (Figure 1), and support time compared to obstacle free gait. Hip ROM at swing phase, impulse and support time increased and knee angle at step over decreased as obstacle height increased (Table 1). The results of this study show that obstacle height gait differ in some ways from obstacle free gait. The fact that subjects had similar toe to obstacle horizontal distance, obstacle to heel horizontal distance and vertical foot clearance for each obstacle suggests a commonality in the strategy used for negotiating obstacles. The results suggest that this strategy places great emphasis on avoiding toe contact with the obstacles.

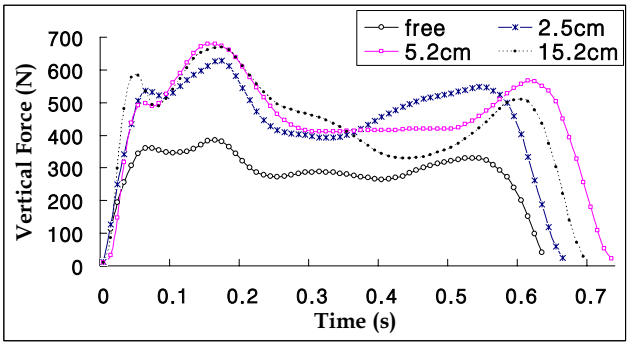

Figure 1: Vertical ground reaction force (subject 5). The ground reaction force pattern was characterized by a wide spectrum of individual differences. In some participants (subject 5), however, vertical force patterns similar to the normal pattern were observed.

REFERENCES

1. Matteo C. *Physical Medicine and Rehabilitation* **16**, 303-321, 2002.
2. Chen HC, et al. *J Gerontology* **46**, M196-203, 1991.

Table 1: Summary of the changes in the kinematic and ground reaction force data (Mean ± SD)

Parameter	Obstacle Height (cm)			
	0	**2.5**	**5.2**	**15.2**
Vertical foot clearance (cm)	4.8 ± 0.8	13.5 ± 3.6	11.2 ± 2.4	13.6 ± 1.0 *
Toe - obstacle distance (cm)	31.0 ± 17.5	21.2 ± 2.3	24.7 ± 8.2	21.0 ± 5.9
Obstacle - heel distance (cm)	13.2 ± 1.1	21.5 ± 3.0	22.2 ± 2.1 *	21.3 ± 1.6
Knee angle at step over (°)	161.6 ± 3.5	123.1 ± 28.6	108.1 ± 4.1 *	90.8 ± 0.2 *
Hip sway angle at step over (°)	-9.2 ±1.1	-0.8 ± 6.5	7.0 ± 1.6 *	4.2 ± 2.4
Knee ROM at swing phase (°)	37.8 ± 3.7	60.5 ± 15.1	53.1 ± 3.0 *	77.9 ± 2.9 *‡
Hip ROM at swing phase (°)	27.4 ± 2.9	34.4 ± 1.2	51.9 ± 0.2 †	65.3 ± 0.1 *†‡
Impulse(%BW-s)	0.4 ± 0.1	0.6 ± 0.0 *	0.6 ± 0.0 *	0.7 ± 0.1 *†
1st peak force(%BW)	1.1 ± 0.1	1.3 ± 0.1	1.3 ± 0.1 *	1.1 ± 0.1
Post obstacle clearance support time (s)	0.59 ± 0.04	0.68 ± 0.03 *	0.70 ± 0.48 *	0.90 ± 0.67 †

* Significantly different from the 0-cm condition ($p < .05$). † Significantly different from the 2.5-cm condition. ‡ Significantly different from the 5.2-cm condition.