A Biomechanical Analysis of Loading Patterns in Children with Cerebral Palsy Using the UpSee

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Background and Objectives

• Cerebral palsy (CP) often leads to secondary deficits including altered gait mechanics and musculoskeletal abnormalities1, and as a result, CP has been associated with limitations in physical activity2,3,4.

• Physical therapy services can facilitate gains in activity level, but solutions for increasing the amount and intensity of physical activity at home must also be explored.

• The UpSee is an upright mobility system that enables coupled walking for young children who cannot stand or walk independently via a shared sandal and harness system.

• The UpSee is a practical, low-cost solution to home activity programs emphasizing mobility for activities of daily living.

• To date, no description of the device’s biomechanical impact has been published, yet, the popularity of the UpSee is evident, with more than 7,000 UpSee systems sold in the global market.

• The purpose of this study was to generate a preliminary understanding of loading patterns associated with UpSee use to inform clinical practice, as many therapy interventions enjoy only small to moderate effect sizes.

Methods

• All biomechanics data were gathered during a single visit to the medical center’s motion analysis laboratory.

• Loading patterns were collected during 5 walking trials in the UpSee, using the Pedar insole pedobarography system (Novel GMBH).

• Trial data were averaged and compared to loading patterns collected during 5 “typical” gait trials, which included the use of orthotics and/or assistive devices if part of the subjects’ typical, everyday walking conditions.

• Novel software was used to calculate weight distribution in different regions of the foot (hindfoot, midfoot, forefoot) and the total foot, with data reported as maximum force normalized to percent body weight.

Results

• Analysis with the Wilcoxon signed rank test found that total foot force was significantly lower when participants were in the UpSee system (M = 54.2, SD = 15.7) vs. in typical walking conditions (M = 62.7, SD = 23.1; z = -2.025, p < .05).

• A lower total foot force appears to be due to a significant decrease in force occurring in the midfoot during UpSee-assisted gait (M = 13.8, SD = 8.4; typical walking M = 17.1, SD = 14.5; z = -2.3084, p < .05).

• Trends toward decreased hindfoot force and increased forefoot force were also observed in the UpSee condition relative to typical walking condition, but did not meet thresholds for statistical significance.

Figure 1: Average max force as a percent of body weight in the different foot regions for UpSee and typical walking conditions.* denotes statistical significance (p < 0.05).

Figure 2: Subject and adult within the UpSee ambulating with orthoses donned and Pedar insole in place.

Figure 3a-b: Pedar analysis of max force distribution for left foot region for one subject under a) typical walking conditions and b) walking within the UpSee.

Conclusions

Typical walking conditions appear to be associated with greater total force and a pattern of forces that more closely approximate a physiologically “healthy” walking pattern (heel-toe gait) in comparison to an UpSee-assisted gait.

Clinical Relevance

• While a greater total force occurs with typical walking conditions, the UpSee promoted active participation during ambulation, as participants did accept load through the lower extremities during UpSee-assisted stepping.

• Accordingly, this system affords a weight-bearing opportunity in the home/community that may provide a muscle and bone loading benefit over sedentary behavior.

References


