Author(s): Piitulainen, H.; Rantalainen, Timo; Kulmala, J. P.; Mäenpää, H.

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P 042 - Gait complexity quantified using inertial measurement units in children with cerebral palsy

H. Piitulainen[1,2], *T. Rantalainen*[3], *J.P. Kulmala*[1], *H. Mäenpää*[1]
[1]*Helsinki University Hospital Children and Adolescents, Motion Analysis Laboratory, Helsinki, Finland*
[2]*Aalto University School of Science, Department of Neuroscience and Biomedical Engineering, Espoo, Finland*
[3]*Faculty of Sport and Health Sciences- University of Jyväskylä, Gerontology Research Center, Jyväskylä, Finland*

Introduction

Children with cerebral palsy (CP) have various gait impairments, and consequently their gait is less stable compared to typically developed (TD) controls. Gait kinematics are also affected more in CP than TD by concurrent dual and cognitive tasks. Inertial measurement units (IMU) provide efficient tool to quantify gait stability, but the practical value of IMU based gait assessment has not been tested in children with CP.

Research Question

We aimed to test the capability of IMU based methods to reveal CP-related gait complexity alterations. We further aimed to identify the effects of cognitive and dual tasks on gait variability in both children with CP and TD controls.

Methods

We extracted gait complexity from 12 children with CP (12.6 ± 2.2 years) and 23 TD controls (13.9 ± 2.2 years) using IMU placed on the mid-back at lumbar spine (L3–L5 level) with tightly fitted Velcro-strap. The data were collected for normal and dual-tasks (motor; carrying a tray, cognitive; word naming) during walking at preferred speed up and back a 10-m long path (~400 steps/task were collected). Step duration (from heel-strike to contralateral heel-strike) and adjusted multiscale entropy (MSE; 20 temporal scales) index were computed from the IMU data separately for vertical and resultant horizontal accelerations. MSE results were summarized with varimax principal component analysis, and the 1st principal component was used for further analysis.

Results

Children with CP had shorter step duration (normal 0.48 ± 0.03 s, motor 0.49 ± 0.04 s, cognitive 0.51 ± 0.04 s) than TD (normal 0.52 ± 0.04 s, motor 0.52 ± 0.05 s, cognitive 0.54 ± 0.05 s; $p=0.032$), and greater gait complexity both in vertical (CP: normal 0.44, motor 0.45, cognitive 0.92 vs. TD: normal –0.37, motor –0.42, cognitive –0.15; $p = 0.004$) and horizontal ($p < 0.001$) directions.

There were no significant task x group interactions. However, step duration was longer for the cognitive than normal (TD $p = 0.001$, CP $p = 0.003$) and motor (TD $p = 0.001$, CP $= 0.001$) tasks

in both groups. In children with CP, the gait complexity in vertical direction was higher during the cognitive than normal (TD $p = 0.121$, CP $p = 0.026$) and motor (TD $p = 0.081$, CP $p = 0.018$) tasks, but not in horizontal direction ($p = 0.582$). Gait complexity was not significantly affected by dual-tasking in TD.

Discussion

As expected, the IMU-assessed gait kinematics and complexity (1) differed between children with CP and TD, and (2) differed between single- and dual-tasking in children with CP. However, the changes from single- to dual-tasking in children with CP did not differ from TD. The present results indicate that IMUs may provide a low-cost surrogate for more detailed gait assessment methods.