Analysis and representation of inertial measurement data to support therapy of children with cerebral palsy

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Summary

Analysis of locomotor patterns of children with cerebral palsy (CP) in the clinical setting at present relies on observation and 2D video analyses. To support physiotherapists in externalization of therapy results and defining quantitative optimization parameters, the practicality of gait analyses with inertial measurements units (IMUs) to monitor the effectiveness of Vojta therapy was tested. The children perform a 5m walking test pre-treatment and shortly before ending the therapy block. The condensed results of inertial measurement data analysis are represented in different ways; usability under clinical conditions is tested.

Introduction

Cerebral palsy (CP) is a developmental disorder of movement and posture that can be positively influenced with physiotherapy intervention. Following physiotherapy treatment using Vojta therapy, we regularly observe improvements in gait characteristics like smoothness and symmetry, with the trunk more upright and moving around midline in children with CP walking independently. These gait parameters are inseparable components of automatic postural control. Although the trunk plays an crucial role in stability and efficiency of gait, usually lower extremity joint angles and spatiotemporal gait parameters are studied for children with CP. Cross-sectional studies using IMUs to quantify these parameters allowed to distinguish differences in the gait pattern between children with CP and typically developing children [e.g. 1,2]. Since this disorder is an umbrella term for non-progressive, but often changing motor impairment syndromes, group norms as references for biomechanical analyses and therapy goals are difficult. The use of IMUs to measure the outcomes of physiotherapy interventions in children with CP [3] in literature is sparse.

We study the applicability of condensed parameters from IMU measurements for children walking independently to support physiotherapy treatment.

Methods

At DRK-Kinderklinik Siegen a cohort of 12 children with CP (intervention group) were given 20 Vojta therapy treatments carried out by specialised physiotherapists within twelve days. Prior to treatment on day one (T1) and after the 18th treatment (T2) IMU measurements were taken during walking under defined conditions. A reference group of age and gender matched typically developing children is used to see which ranges of values exist for these children. This approach will allow us to improve interpretation of changes in the intervention group.

A setup with four APDM Opal^{TM} triaxial motion sensors including accelerometer, gyroscope and magnetometer is used in combination with a 2D video system. The sensors are fixed on the skin over the *sternum, L4/5 lumbar vertebrae*, and the *dorsum* of both feet. The sampling frequency is 128 Hz. The children walk on a level track at a self-selected speed three times in a straight line five meters back and forth.

Results and Discussion

We analysed data from the sternal and lumbar IMU for selected gait parameters from the first 12 study participants. We see differences between T1 and T2 data condensed parameter values for each of these children. Considering the complexity and heterogeneous nature of CP along with the unique characteristics of the children e.g. age and gait speed, the identification of general parameters and their impact demands a broader database. The availability of objective parameters (cp. Figure 1) will allow therapists to define hypotheses about key factors influencing the individual movement patterns, in order to optimize the therapy in comparison with the results of video analyses.

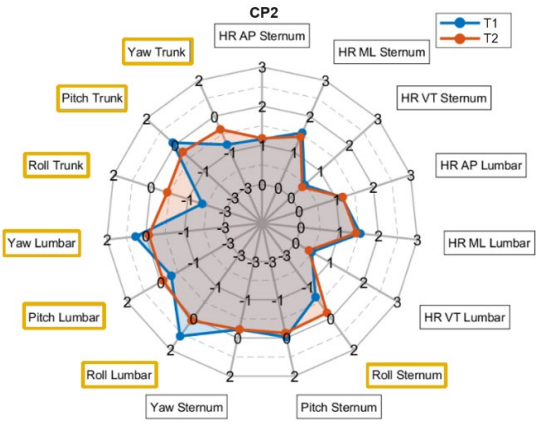

Figure 1: Radar plot for multiple parameters for T1 (blue) and T2 (orange) for participant #2

Conclusions

Motion analysis with IMUs is feasible with children undergoing physiotherapy treatment. Condensed parameters from motion analyses support the optimization of therapy. Visualization of results allows simple access to the therapy effects. The feasibility study is still in progress.

References

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