Balance Control and Muscle Co-Contraction Differences during Sit-To-Stand between Children with Cerebral Palsy and Typically Developing

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Summary

We measured thigh muscle co-contraction and center of pressure measures for balance control during sit-to-stand in three children with cerebral palsy (CP, Gross Motor Classification System III) and compared findings (Cohen's d effect size) with two typically developing (TD) peers. Impaired balance control in children with CP was quantified with larger, more variable thigh co-contraction in contrast to TD children despite smaller center of pressure displacement and velocity due to needed hand support to perform the task.

Introduction

Rising from seated position requires balance control and lower limb strength, key for functional activities, especially for children with disabilities. For children with cerebral palsy (CP), the most common pediatric motor disability, sit-to-stand intervention improved mobility and reduced caregiver burden [1]. Compared to typically developing (TD) peers, CP with high motor function (GMFCS I) exhibited impaired balance control during standing with greater center of pressure (COP) variability [2]. In contrast, those with CP and lower motor function (GMFCS II, III) showed reduced COP variability due to hand support to maintain upright posture [3]. Despite these observations, research on muscle coordination patterns impacting balance control for those with lower motor function (GMFCS III) remains limited. Our novel study investigated thigh muscle co-contraction and COP measures for balance control during sit-to-stand in CP (GMFCS III) and contrasted findings with TD children. Given agonist-antagonist muscle coordination is impacted due to primary cortical injuries in CP [4], we hypothesized CP would exhibit higher co-contraction [5] but lower COP [2] values than TD due to hand support.

Methods

Two girls (4yo) and one boy (7yo) with CP (GMFCS III), and two boys TD (4yo, 10yo) performed the Sit-To-Stand task from adjustable bench allowing 90° of hip and knee flexion (Figure 1A). While TD performed unassisted, CP required hand support. Outcome variables were knee flexor-extensor co-contraction (extensor as divisor), COP Root Mean Square anteroposterior (RMSap) and mediolateral (RMSml), and COP velocity. Successful standings (from initial vertical force rise to stable force and highest cervical marker position) were used. Given study's small sample, descriptive statistics defined biomechanical behavior and Cohen's d effect size exposed magnitude of differences between groups.

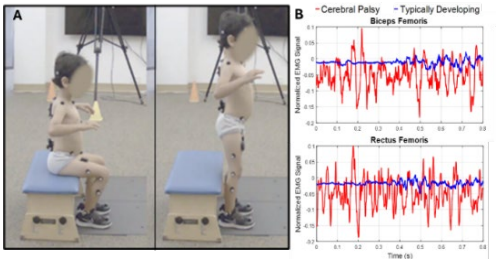

Figure 1: **A)** TD child performing the sit-to-stand; **B)** EMG signal (representative) from knee flexor (biceps femoris) and extensor (rectus femoris) contrasting child with CP and TD during the task.

Results and Discussion

CP completed 16 standing and TD 24 standing trials. Near large effect size (0.7)was observed *for thigh co-contraction:* CP averaged (±stdev) 1.34±1.10, TD 0.78±0.25. Coefficient of variation (CV%) for co-contraction was CP 61% vs TD 38%. *For RMS*, moderate (0.4) and large (1.6) effect sizes were observed for RMSap and RMSml: CP 208±121mm and 203±61mm, TD 245±45mm and 305±66mm, respectively. CV% of RMSap and RMSml were CP 58% vs TD 18%, and CP 30% vs TD 22%, respectively. *For velocity*, large (0.9) effect size was observed: CP 133±53mm/s, TD 190±68mm/s. CV% of velocity was for CP 40% vs TD 36%.

Conclusions

Impaired balance control in children with CP was quantified during the sit-to-stand task with larger, more variable thigh co-contraction compared to TD children despite smaller COP displacement and velocity due to hand support. Further work with larger sample is underway to extrapolate findings.

Acknowledgments

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