THE LINK BETWEEN POSTURAL CONTROL AND GAIT IN CHILDREN WITH BILATERAL CEREBRAL PALSY

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Introduction

Children with cerebral palsy (CP) present atypical body posture patterns and abnormal gait patterns resulting from functional strategies to compensate process for primary anomalies, that are directly attributable to damage to the central nervous system.

CP can be unilateral or bilateral. Unilateral CP (UCP) is a subtype affecting the limbs on one side of the body, whereas bilateral CP (BCP) affects the limbs on both sides of the body.

Although our previous studies provided evidence for a strong correlation between postural and gait patterns control in children with UCP (Szopa A, Domagalska-Szopa2014; Domagalska-Szopa and Szopa 2017) little is known about these dependences in children with BCP.

Purpose

The aim of this study was to elucidate the relationship between body posture control and gait disorders in children with BCP and to verify our hypothesis of there being a strong association between them by statistical methods of canonical correlation analysis and structural equation model in this population.

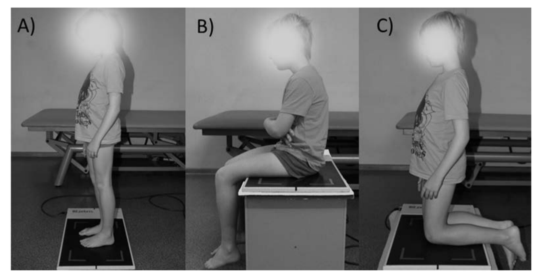
Participants

There were recruited to the study 80 children with BCP, who were patients of local paediatric rehabilitation centres (30 females and 50 males) aged from 7 to 13 years (mean age =11.4 y (SD 3y). Participants were classified into Gross Motor Function Classification System (GMFCS) level I (n = 33), II (n = 39), and III (n=8).

Methods

Present study obtained two inter-related parts:

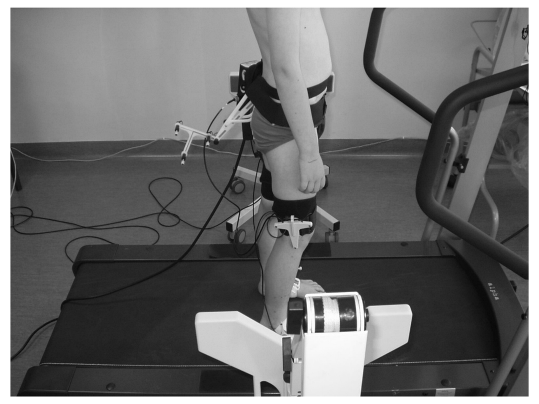
POSTUROGRAPHIC TESTS DURING: QUIET STANCE, SITTING, AND KNEELING WITH THE EYES OPEN



	1. Stability indices based on COP shifts
MCoCx	mean of points with x-coordinates (medial-lateral direction) of COP
MCoCy	mean of points with x-coordinates (posterior-anterior direction) of COP
SPL1 [cm]	sway path lenght of COP (SP)
SDx	standard deviation of x'
SDy	standard deviation of y'
	2. The stability indices, based on area of surface of COP
WoE [cm]	width of an ellipse medium (lateral sway path of COP)
HoE [cm]	hight of an elipse (posterior sway path of COP)
AoE [cm^2]	area of surface of centers of pressure of COP (calculated from COP shifts in such a way that 95% of the data is within the ellipsoid, and 5% outside).
PoE [cm]	parameters of medial-lateral and anterior-posterior linear displacement of COP (the inclination of the major axis)
A_PoE [cm]	absolute values of parameters of medial-lateral and anterior-posterior linear displacement of COP (the inclination of the major axis)

The paedobarographic measuremets was recorded three times (3 trials, each lasting for 30 s, with a 30 s pause between trials), using a force platform (PDM, Zebris). The mean values from three trials were used to statistical analysis.

3 DIMENSIONAL INSTRUMENTED GAIT ANALYSIS. THE GAIT DATA WAS RECORDED AS THE PARTICIPANTS WALKED BAREFOOT ON A TREADMILL



The procedure of trials included three trials with comfortable walking speed were averaged and then analysed.

To characterize the gait, the Gillette Gait Index (GGI) as well as the 16 distinct gait parameters they composed were use: 1) stance phase expressed as a percentage of gait cycle; 2) walking speed normalized to leg length; 3) cadence; 4) mean pelvic tilt; 5) range of motion (ROM) of pelvic tilt; 6) mean pelvic rotation; 7) minimum hip flexion; 8) ROM of hip flexion/extension; 9) peak hip abduction in swing; 10) mean hip rotation in stance; 11) knee flexion at initial contact; 12) time to peak knee flexion in swing expressed as the percentage of the gait cycle; 13) ROM of knee flexion; 14) peak dorsiflexion in stance; 15) peak dorsiflexion in swing; and 16) mean foot progression (Schutte et al., 2000).

Methods

GGI is a single number, derived from gait kinematics and spatio-temporal parameters that quantify the deviation of pathological gait from normal gait. The relationship between the variable set Postural Control Indices (predictor set) and variable set Gait Kinematics (criterion set) was analysed using canonical correlation analysis (CCA).

Results

Results for the structural equation model showed statistically significant F (117, 618·88) = 2·21 (p < ·001, λ = ·07) and yielded four functions, wherein R2c values were equal to ·58, ·48, ·30, ·25, for each successive function. In further analysis, only Functions 1 was included.

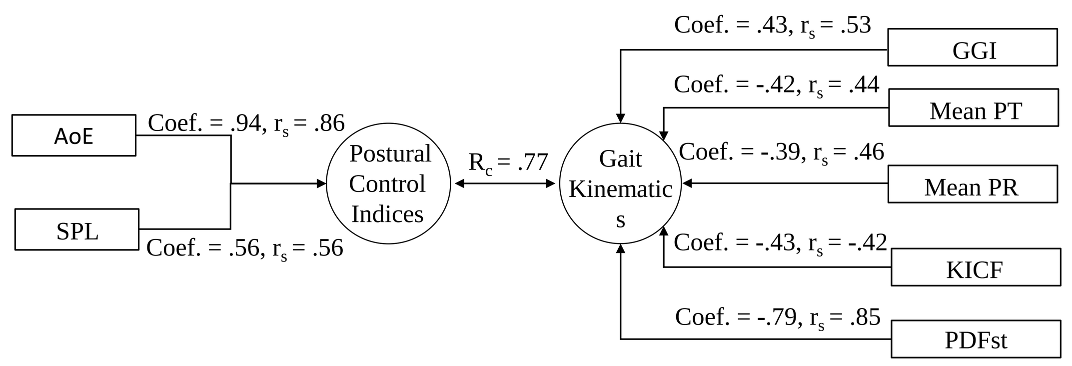


Figure 1. Illustration of the Function 1 in a canonical correlation analysis with a predictor variable set with two variables (Postural Control) and criterion variable set with five variables (Gait Kinematics). Coef = standardized canonical function, rs = structure coefficient, rs2 = squared structure coefficient. The canonical correlation (Rc) is a simple Pearson correlation (r) between the synthetic variables, which were linearly combined from the observed variables.

Our findings documented that two of Postural Control indices, such as: area of CoP [AoE] and sway path length of the CoP [SPL] in standing were significantly related to the deviation of pathological gait from normal gait (expressed by GGI) and to the four kinematic deviations during gait cycle such as: mean pelvic tilt [MPT] and mean pelvic rotation [MPR], and knee flexion at initial contact [KICF] and peak dorsiflexion in stance [PDFst].

Discussion & Conclusions

The postural instability (expressed by larged area and sway path length of CoP) tended to involve not only of the increased deviation of pathological gait from normal gait, expressed GGI (theoretically expected relationships) but also abnormalities of pelvic movements (deficits of tilt and rotation), as well as deficits of knee flexion and ankle (peak dorsiflexion in stance) movements.

Present study provides evidence for a strong correlation between postural instability and gait deviations in children with BCP.

Recommendations

Specific and early treatment approaches (depending on the postural instability) can include improving the gait pattern in these children.

References

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Further information

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