

## MUSCLE DYSFUNCTION DURING WALKING IN CHILDREN WITH CEREBRAL PALSY

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### INTRODUCTION

Cerebral palsy (CP) is a disorder of movement or posture due to a lesion in the immature brain [1]. Release of the gamma system from higher inhibitory control results in the muscles being hyperexcitable [2], and they exhibit elevated muscle tone and excessive co-contraction during walking [3].

CP is typically assessed using gross measures of gait (e.g. walking velocity), or overall motor function and sometimes by the joint kinetics. However, none of these measures are direct measures of the muscle dysfunction.

The purpose of this study was to quantify the differences in the myoelectric activity between children with CP, and healthy controls, in order to determine the extent of the muscle dysfunction during walking.

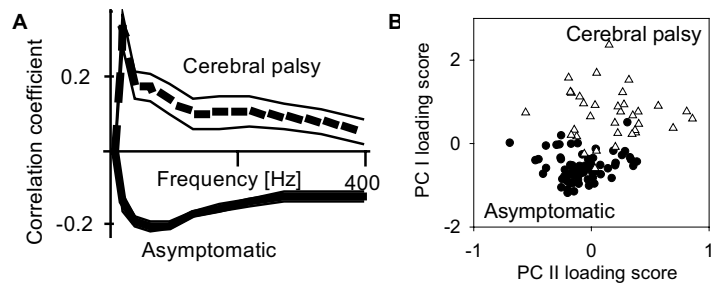
### METHODS

Surface electromyography (EMG) was performed bilaterally on the rectus femoris, semimembranosus, medial gastrocnemius and tibialis anterior from 36 healthy children and young adults (age range 3.1 – 21.0 years) and 17 children and young adults with CP (4.8 – 21.5 years). Each child walked along a walkway at their preferred velocity. Segmental kinematics were used to determine the time of foot-contact with the ground, and thus to window the walking into stance phase, swing phase, or the entire stride cycles. Data were analyzed from 5-15 strides per individual.

The EMG was resolved into its intensity (a correlate of the power of the signal) in time-frequency space using wavelet techniques [4]. The intensities (at each frequency-band analyzed) were correlated between antagonistic muscles. Correlations were thus calculated across a range of frequencies to make a spectrum. The correlation spectra were used as a measure of the co-contraction. Correlation spectra between the asymptomatic and cerebral-palsied conditions were compared using principal component techniques [5].

### RESULTS AND DISCUSSION

Intensity spectra showed that the cerebral-palsied condition had systematically higher mean EMG frequencies than the asymptomatic controls. The extensor muscles (rectus femoris and medial gastrocnemius) showed higher intensities, but the tibialis anterior intensity was less than the asymptomatic condition (Table 1). The results show that the muscle is either activated in a different way, or that the muscle structure is



**Figure 1:** [A] Correlation spectra (mean  $\pm$  s.e.) and [B] principal component (PC) loading scores for co-contractions for all subjects between the tibialis anterior and medial gastrocnemius during walking

different in the children with CP. This type of analysis can direct future research questions.

The correlation spectra showed that the cerebral-palsied condition has different (but not always greater) patterns of co-contraction (Fig. 1A). Co-contractions in the cerebral-palsied muscles were always greater in the low-frequency range (<100 Hz) of the myoelectric spectra, and may indicate a greater involvement of the slower motor units for co-contractions [5]. The principal components of the co-contraction could be distinguished between the cerebral-palsied and asymptomatic conditions, and were most different for the more distal muscles (Fig. 1B).

### CONCLUSIONS

The EMG signals during walking are markedly different between children with cerebral palsy and asymptomatic controls. Time-frequency analysis of the spectra and the co-contractions provide direct measures of the muscle dysfunction and have an application for quantifying the severity of the condition or the efficacy of treatment.

### REFERENCES

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**Table 1. Changes in the EMG spectra during walking.** Arrows indicate if the children with cerebral palsy had significantly (t-test:  $p < 0.05$ ), greater or smaller intensity or frequency from their EMG signals compared to the asymptomatic controls.

Muscle	Stance phase		Swing phase		Stride	
	Mean intensity	Mean frequency	Mean intensity	Mean frequency	Mean intensity	Mean frequency
Rectus femoris	↑	↑	↑	↑	↑	↑
Semimembranosus	n.s.d.	↑	n.s.d.	↑	n.s.d.	↑
Tibialis anterior	↓	↑	↓	↑	↓	↑
M. gastrocnemius	↑	↑	n.s.d.	↑	n.s.d.	↑