

## Temporal and frequency characteristics of trunk and hip muscle activity patterns in early walkers with and without cerebral palsy.

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### INTRODUCTION

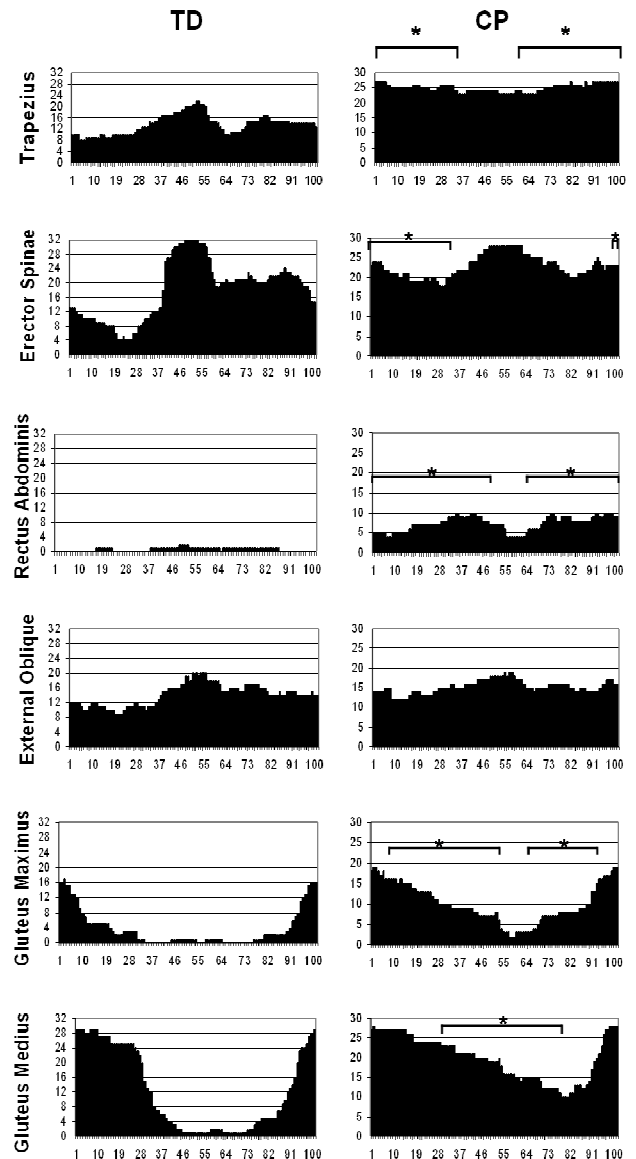
Cerebral palsy (CP) is the most common neuromuscular disorder in children, with a high economic cost and negative impact on quality of life. Poor control of postural muscles is often considered a primary impairment in CP, which causes compensation by other muscles to assist in maintaining upright posture, and thus limiting those muscles from functioning effectively as primary movers of the extremities. Information on how the trunk and gluteal muscles function during walking will assist in understanding their role to maintain upright posture during walking and facilitate the development of interventions to address deficits in their function.

The objective of this project was to investigate differences in trunk and hip muscle activation patterns during the early stages of walking in children with spastic CP compared to children with typical development (TD).

### METHODS

**Participants.** Thirty-one children (15 CP, 16 TD) were included in this study. All participants had 0.5-60 months of walking experience, with an average of 28.5±18.1 months in both groups. The children with CP also had a GMFCS level of II or III.[1] All procedures were approved by the Temple University Hospital IRB. Parental consent was obtained prior to participation and assent was obtained from participants 7 years of age or older.

**Procedures.** Surface electromyographic (EMG) data were acquired bilaterally from the trapezius, erector spinae, rectus abdominus, external oblique, gluteus maximus and gluteus medius (Myomonitor III, Delsys Inc., Boston, MA). EMG data were collected at 1200 Hz, preamplified, and bandpass filtered from 20-450 Hz. Children walked barefoot down an instrumented walkway (GAITRite®, CIR Systems,



**Figure 1:** Histograms for number of children with muscle activity at each point in gait cycle in TD and CP groups. Left and right sides were counted individually. Asterisks (\*) indicate periods of activity where the CP group has significantly more children with muscle activation than the TD group.

Havertown, PA) at a self-selected pace to collect time-synchronized footfall data used to identify initial foot contact.

**Data analysis.** Ten gait cycles (5 left, 5 right) were selected for analysis. EMG data were processed using custom-written programs in MATLAB (The Mathworks Inc., Natick, MA). All signals were normalized to 1000 points, representing the gait cycle from 0 to 100% in 0.1% increments. The timing of muscle activity onset was determined in reference to a static baseline using the Teager-Kaiser Energy (TKE) operator.[2] The number of children in each group who had activity in the muscle at each point in the gait cycle was determined. The chi square test,  $\chi^2$ , was performed at each point in the gait cycle to determine if significant differences ( $p < 0.05$ ) existed between groups in the number of children who had activity in the particular muscle.

Additionally, a time-frequency pattern for each muscle was generated using the continuous wavelet transform.[3] A functional principal component analysis (PCA) was used to identify variability in the instantaneous mean frequency (IMNF) curves between the groups. The four PCA output weights were tested using a Welch statistic to determine if the differences existed between the groups.

## RESULTS AND DISCUSSION

The CP group had significantly more children with activation than the TD group for all muscles except the external oblique. Locations of differing activity during the gait cycle are indicated by asterisks in Figure 1.

The CP group also had higher mean frequency throughout the gait cycle for all muscles (Figure 2). Higher IMNF can result from increased rates of motor unit firing, increased number of recruited motor units, or decreased synchrony of motor units [4], and may contribute to muscle fatigue in children with CP.[5] Limitations of the study include the use of an assistive device by some children in the CP group, and the potential influence of recording activity from adjacent deep trunk muscles.

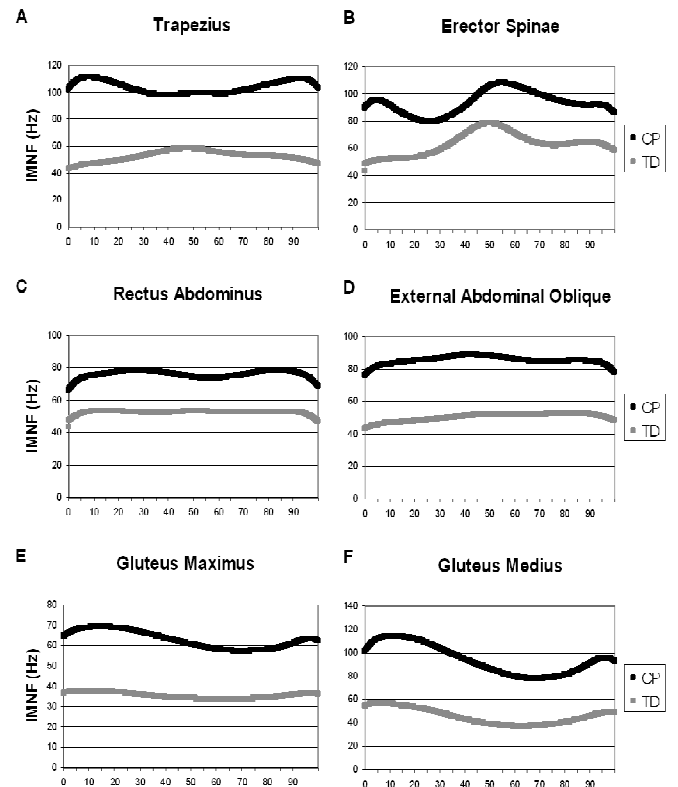


Figure 2. IMNF curves in CP and TD groups. All muscles were significantly different between groups for each principal component ( $p < 0.000$ ). The four PCA harmonics accounted for over 97% of the variability for each muscle.

## CONCLUSIONS

Children with spastic CP demonstrate greater activity in the trunk and hip muscles than children with TD. Postural muscle training during the early stages of walking in CP should be investigated to encourage the development of more functional and efficient movement strategies in these children.

## REFERENCES

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## ACKNOWLEDGEMENTS

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