Discussion

Footwear properties can have a large effect on gait outcomes when walking with AFOs. Based on the simulations, having a forefoot rocker and some heel-toe differential is most beneficial, although the best combination depends on AFO stiffness. For clinical practice this means that both footwear and AFO properties should be optimize in conjunction to maximize results, which warrants future experimental studies.

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Clusters of frontal knee angle range-of-motion in healthy people during level walking

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Introduction

Level walking (LW) is among the most investigated human motor tasks. Various papers on normative gait data of healthy participants [1,2] and characteristic deviations of subgroups [3] or in comparison to pathological conditions [4,5] have been published. However, control of frontal leg alignment, its kinematic and kinetic indicators, and their cut-offs concerning sustainable joint health are still not fully understood [6]. Therefore, we started establishing a database on LW for in depth investigation of normal gait in healthy adults.

Research Question

Is frontal knee range of motion (fKROM) a suitable parameter for classifying subgroups of dynamic functional leg alignment qualities during LW in healthy adults?

Methods

Seventy-five (40 female / 35 male) healthy participants aged 19 to 65 (mean 34 ± 13.6) years with BMI 18.5 to 30.39 (mean 23.6 ± 2.5) kg/m2 performed LW. Data were captured by a 3D marker-based system (Vicon Nexus) using the modified Cleveland Clinical markerset and three force plates (AMTI). Processed gait cycle trials were time-normalized. Based on dominant leg fKROM a k-means cluster analysis (k = 3) identified subgroups of participants. Discrete gait parameters were analyzed for differences between the three clusters using one-way ANOVA with Bonferroni posthoc testing. Further, lower limb kinematics over the entire gait cycle were assessed using one-dimensional statistical parametric mapping (1D-SPM) with one-way ANOVA ($p < 0.05$) to detect differences between clusters.

Results

fKROM ranged from 0.8° to 4.4° (mean 2.3° ± 1.0°) with cluster centers of 1.4° (n = 31), 2.3° (n = 26) and 3.7° (n = 18). Neither, spatio-temporal parameters, nor other relevant frontal and transversal knee, hip and pelvis angles, and external frontal moments differed significantly between the three clusters. Concurrent 1D-SPM analysis revealed no significant differences across clusters for any of the tested kinematic parameters. (Figure 1)

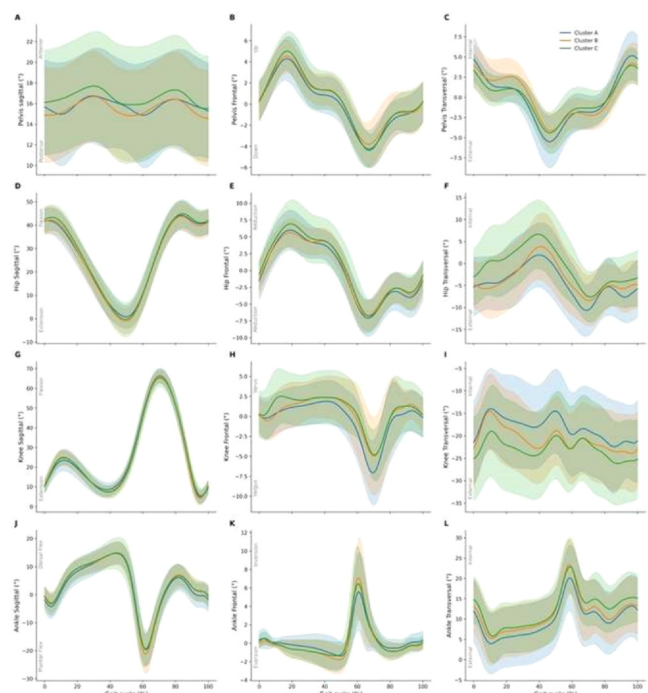

Figure 1: 1D-SPM plots of kinematic parameters by clusters of fKROM

Discussion

Findings from this preliminary analysis suggest that individuals do not differ in relevant loading-response phase gait parameter point estimates nor across the entire gait cycle, despite the identification of distinct fKROM clusters. A combined parameter other than fKROM during loading phase, which is not yet established, may be more sensitive to characterize dynamic functional leg alignment. Furthermore, kinematic patterns indicative of unfavorable dynamic alignment should be investigated in relation to kinetic overloading to enhance clinical relevance.

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Perturbation training improves muscle coordination during reactive standing balance in trained and untrained conditions in children with cerebral palsy

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Introduction

Balance impairments are common in cerebral palsy (CP). When standing balance is perturbed using support-surface displacements, children with CP step at lower perturbation amplitudes and have higher levels of muscle co-activation than typically developing (TD) children (1–4). Perturbation training is a promising tool to improve reactive balance (5). However, it is unclear whether perturbation training normalizes muscle coordination in children with CP.

Research Question

What is the effect of perturbation training on reactive balance performance and reactive muscle activity during trained and untrained tasks in children with CP and TD children?

Methods

Children with CP (GMFCS: I-II; age 9-16) and TD children (age 8-16) were assessed before and after a training intervention consisting of nine sessions over three weeks. Participants were asked to maintain standing balance in response to toe-up rotations (96 per session; fig1). Perturbation magnitude was adapted to the participant's performance level. We assessed balance performance and muscle coordination in trained toe-up rotational and untrained backward translational perturbations of standing balance. Balance performance was assessed as the number of perturbations completed without stepping. The magnitude of muscle activity was computed as the average filtered and scaled EMG (lateral gastrocnemius (LG), medial gastrocnemius (MG), soleus (SOL), and tibialis anterior (TA)) from 200 to 450ms after perturbation onset, the time bin in which we previously observed the largest differences in reactive muscle activity between children with CP and TD children (4). Muscle co-activation was assessed using the co-contraction index (CCI), i.e. the overlap between TA and respectively LG, MG, and SOL filtered and scaled EMG 0 to 1.5s after perturbation onset.

Results

Preliminary results are based on data from 6 (out of 11) children with CP and 4 (out of 11) TD children. Perturbation training improved the ability of children with CP to withstand perturbations without stepping. Reactive muscle activity in plantarflexors and dorsiflexors decreased after training during rotational (mean pre-post LG activity of 0.02 vs. 0.01 in TD, 0.51 vs. 0.07 in CP) and translational (mean pre-post LG activity of 0.37 vs. 0.22 in TD, 1.45 vs. 0.76 in CP) perturbations (fig1). Muscle co-activation also decreased during rotational (CCI pre-post of 0.17 vs. 0.10 in TD, 0.68 vs. 0.38 in CP) and translational perturbations (CCI pre-post of 0.19 vs. 0.12 in TD, 0.46 vs. 0.32 in CP) (fig1).

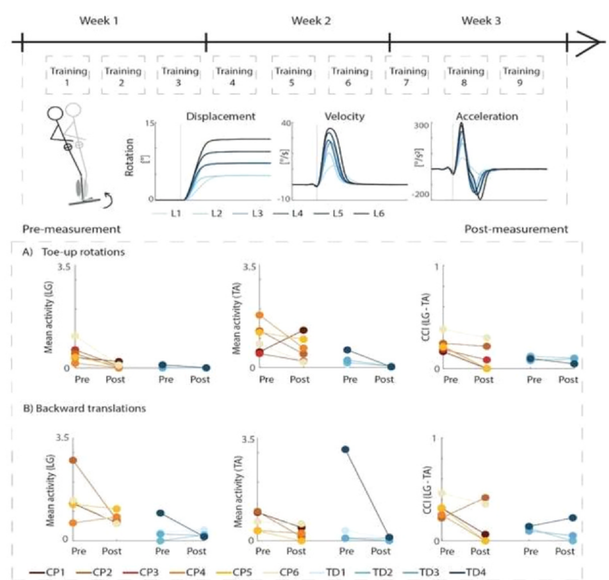

Figure 1: Experimental set-up (top panel). Platform kinematics for the different perturbation levels (L1-L6) for toe-up rotations used during training. Average normalized EMG for the lateral gastrocnemius (LG) and tibialis anterior (TA) and co-contraction index (CCI) for level 2, (A) toe-up rotational perturbations and (B) backward translational perturbations. Children with cerebral palsy (CP) in red-yellow and typically developing (TD) children in blue.

Discussion

Our preliminary results suggest that reactive balance control can be trained in children with CP. After training, the muscle response to perturbations was smaller in both children with CP and TD children and co-activation was reduced in children with high levels of co-activation pre-training. Overall, the response to perturbations of children with CP was more similar to the response of TD children after training.