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referenced to head sways, Condition4: standing on foam/walking with foam insoles with eyes open. Condition5: standing on foam/walking with foam insoles with eyes closed. Condition6: standing on foam/walking with foam insoles while the VR screen sways as referenced to head sways. Each condition will be randomized and performed for 1 minute (4,5). The center of mass (CoM) will be estimated for both standing and walking tests. The agreement and correlation between standing SI and UHLSINT will be investigated by calculating the kappa coefficient and Pearson correlation. The Intraclass Correlation Coefficient (ICC) will be calculated to assess the test-retest reliability of the UHLSINT.

Results

NA

Discussion

This study protocol provides detailed information on the development of an SI test during the dynamic task of walking, namely UHLSINT. UHLSINT may provide deeper insight into the SI mechanism under different conditions in different age groups. Subsequently, the findings may have further implications on the underlying sensory mechanisms explaining fall risk and fall prediction in older adults.

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Multi-scale mechanobiological growth simulations can differentiate between individuals with different femoral growth patterns

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Introduction

As bones develop during ontogeny, they not only increase in size but also adapt their shape in response to the loading environment [1–5]. Multi-scale simulations based on cross-sectional data have been used to estimate growth plate loading and differentiate between healthy and pathological femoral growth [6–12]. However, no studies have compared growth plate morphology, femoral loading and multi-scale predictions with longitudinal changes in femoral shape measured from medical images.

Research Question

Do femoral loads, growth plate orientation and growth rates from multi-scale simulations vary between children with different growth patterns?

Methods

Magnetic resonance images (MRI) and 3D gait analysis data of ten typically developing children was collected at two occasions two years apart (age: first session 9.9 ± 0.9 years). Femoral anteversion angle (AVA) and neck-shaft angle were measured from the MRIs by two experienced researchers to ensure high reliability [13]. Personalized MRI-informed musculoskeletal models were used to estimate muscle forces and joint contact forces (JCF) [14,15] and used as input for the multi-scale simulations to predict femoral growth [6,7]. Participants were grouped depending on their change of AVA between data collection sessions. Lower limb kinematics, muscle forces, hip and knee JCF as well as their orientations during the gait cycle, growth plate orientation and growth rates from the multi-scale predictions were compared between two groups, one with low AVA changes ($AVA < \mu - \sigma$) and one with large AVA changes ($AVA > \mu + \sigma$). Statistical parametric mapping [16] was used to compare waveforms between groups.

Results

Children grew 13.5 ± 3.3 cm (range: 9-20 cm) and gained 8.2 ± 3.2 kg of body mass during the two years. Participants' AVA changed between -13.1° and 11.8° (mean: -1.3 ± 5.8°) between sessions. Grouping identified three femurs exhibiting high AVA increase, four femurs with high AVA decrease and thirteen femurs with normal AVA development (Figure 1A). Growth plate orientation (Figure 1B), joint kinematics, muscle forces, JCF (Figure 1C) and their orientations did not show any significant differences between groups. Multi-scale-predictions and measurements of AVA development showed significant correlation (p = 0.002) (Figure 1D). The regions with highest mean growth rates differed and values within the medial region were significantly different between "increase" and "decrease" groups (p = 0.03).

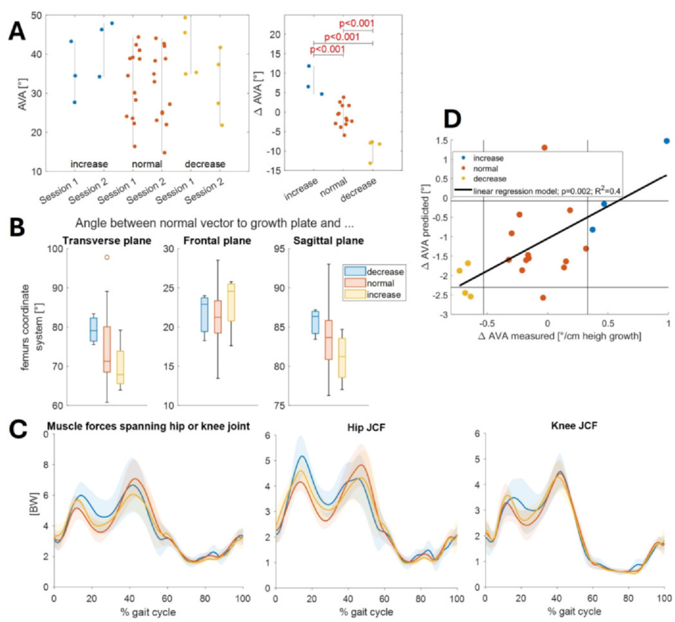

*Figure 1: **A:** AVA and its development separated by groups. **B:** Orientation of vector perpendicular to the proximal femoral growth plate in respect to the femurs coordinate system. **C:** Mean ± standard deviation of muscle and joint contact forces during the gait cycle. **D:** Linear correlation between measured and predicted change of AVA.*

Discussion

Despite the fact that no significant differences were found in joint kinematics, femoral loading and growth plate orientation, multi-scale simulations were sensitive enough to identify differences between groups and predict AVA development with reasonable accuracy. Our results highlight that femoral growth is influenced by a complex interplay between gait pattern, femoral morphology and internal loading. Our preliminary results, based on healthy children, suggest that multi-scale simulations are able to discriminate between different growth patterns. However, longitudinal simulation studies including a larger sample size and individuals with pathological growth are needed to further increase our insights in typical and pathological femoral growth.

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