PI-LL mismatch (ρ = 0.44), thorax flexion during gait (ρ = 0.34), and negatively correlated to knee sagittal ROM (ρ = -0.39) and walking speed (ρ = -0.43; all $p < 0.05$; Fig.1).

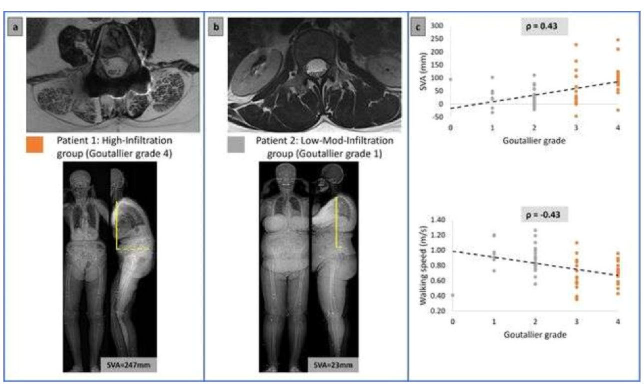
Discussion

The Goutallier classification, an easy and accessible method using routine MRI, can indicate malalignment severity and functional impairment in ASD patients, making it a relevant clinical indicator of disease severity. Thus, a high Goutallier grade should alert clinicians to the need for targeted interventions, such as muscle reinforcement, to mitigate fat infiltration and optimize outcomes in both operative and non-operative patients.

References

[1] Semaan K. et al., European Spine Journal, 2022.
[2] Bao H. et al., European Spine Journal, 2020.
[3] Davis R. et al, Human Movement Science, 1990.
[4] Leardini A. et al., Clinical Biomechanics, 2011.
[5] Schwartz M. et al., Gait & Posture, 2008.

Fig. 1- Example of patients with (a) high and (b) low-moderate muscle fat infiltration; correlations between Goutallier grade, SVA and walking speed (c).



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Influence of anthropometric variation in femur and tibia length on muscle-tendon length during walking

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Introduction

Muscle–tendon lengths (MTL) are critical for understanding movement disorders such as cerebral palsy and developing effective treatment strategies [1]. Although musculoskeletal modelling enables MTL estimation, clinical adoption is often limited by the complexity of scaling and inverse kinematics. Hence, workflows have been developed using joint angles calculated with the conventional clinical gait model and a generic (unscaled) musculoskeletal model to estimate MTL [2]. However, this approach neglects anthropometric variations in segment lengths, which might affect MTL.

Research Question

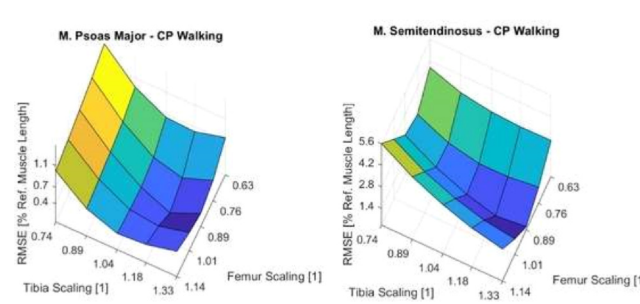
How does anthropometric variations in femur and tibia lengths affect the calculation of MTL?

Methods

Previously collected three-dimensional gait data and joint angles from a healthy participant and one with cerebral palsy were used for the sensitivity analysis. Gait data from both participants, together with the Rajagopal model [3], were used to calculate MTL in OpenSim. MTL from the unscaled model served as reference for all further analysis. Twenty-five additional models were created using varying scale factors. To assess the effect of anthropometric variation, femur and tibia scaling factors were varied across the 95% confidence interval from a normative dataset of 7,970 individuals aged 2–92 years (mean: 16.9 ± 13.1 years). Scaling intervals were defined as [0.63, 1.14] for the femur and [0.74, 1.33] for the tibia. Within each interval, five equidistant scaling factors were selected, resulting in 25 femur–tibia scaling combinations and corresponding OpenSim models. MTL were calculated using all models and both gait kinematics as input. MTL continuity was ensured using the Muscle Moment Arms Checker [4]. Four muscles were analyzed: M. semitendinosus, M. rectus femoris, M. psoas major, M. gluteus maximus. For each motion, muscle, and model, the root mean square error (RMSE) in normalized muscle lengths between scaled and reference models was computed to assess the impact of anthropometric variations on MTL.

Results

Variations in femur and tibia lengths in the simulations based on healthy gait kinematics led to maximum MTL changes in M. semitendinosus, M. rectus femoris, M. psoas major, and M. gluteus maximus of 8.7, 2.1, 0.6, and 4.1%, respectively. In the CP gait simulations, anthropometric variations causeden maximum changes in M. semitendinosus, M. rectus femoris, M. psoas major, M. gluteus maximus MTL of 7.9, 2.6, 0.9, and 5.2 %, respectively.



RMSE of normalized muscle–tendon lengths between scaled and unscaled models across 25 femur–tibia scaling combinations. Kinematics from a child with cerebral palsy. Left: Musculus psoas major. Right: Musculus semitendinosus.

Discussion

Our study showed that anthropometric variations affect MTL. However, only combinations of extreme scaling factors (e.g., femur: 0.63; tibia: 0.74), which are unlikely in practice, caused large discrepancies from the reference MTL. Nevertheless, subject-specific segment ratios should be included in musculoskeletal simulations to ensure accuracy. We aim to develop easy-to-use workflows to estimate MTL and other musculoskeletal parameters in clinical settings.

References

[1] A. Rajagopal, Ł. Kidziński, A.S. McGlaughlin, J.L. Hicks, S.L. Delp, M.H. Schwartz, Pre-operative gastrocnemius lengths in gait predict outcomes following gastrocnemius lengthening surgery in children with cerebral palsy, PLoS ONE 15 (2020) e0233706. https://doi.org/10.1371/journal.pone.0233706.
[2] H. Kainz, M.H. Schwartz, The importance of a consistent workflow to estimate muscle-tendon lengths based on joint angles from the conventional gait model, Gait & Posture 88 (2021) 1–9. https://doi.org/10.1016/j.gaitpost.2021.04.039.
[3] A. Rajagopal, C.L. Dembia, M.S. DeMers, D.D. Delp, J.L. Hicks, S.L. Delp, Full-Body Musculoskeletal Model for Muscle-Driven Simulation of Human Gait, IEEE Trans. Biomed. Eng. 63 (2016) 2068–2079. https://doi.org/10.1109/TBME.2016.2586891.
[4] W. Koller, B. Horsak, A. Kranzl, F. Unglaube, A. Baca, H. Kainz, Physiological plausible muscle paths: A MATLAB tool for detecting and resolving muscle path discontinuities in musculoskeletal OpenSim models, Gait & Posture 117 (2025) S21–S22. https://doi.org/10.1016/j.gaitpost.2025.01.063.

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Sonomyography of the gastrocnemius medialis muscle during walking in persons post-stroke

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Introduction

Sonomyography (SMG) is an emerging tool for the in-vivo study of muscle-tendon behaviour during movement. When combined with 3D gait data, SMG can be used to quantify the behaviour of the gastrocnemius medialis muscle (GM) during gait, a muscle often impaired in subjects with neurological disorders, such as cerebral palsy and stroke. GM SMG in these populations can help identify pathology specific changes in this muscle and how they influence gait recovery. While GM SMG has been well described in children with cerebral palsy [1-3], its feasibility in subjects post-stroke remains unexplored.

Research Question

What are the effects of GM SMG on gait kinematics in persons post-stroke compared to healthy controls and can it capture differences in GM behaviour between these populations?

Methods

3D lower-limb kinematics (Vicon, Oxford Metrics) were collected from 12 persons (6 subjects 7 ± 7m post-stroke and 6 age- and sex-matched controls, mean age 54 ± 8y, 5 males) while they walked at a self-selected walking speed on a treadmill (GRAIL, Motek Medical) with and without SMG (Telemed SmartUS, 59mm linear probe). SMG was collected from the paretic (or corresponding) leg with the ultrasound-probe positioned on the GM muscle-tendon junction (MTJ) using a probe-holder (Probefix DynamicT, USONO -Figure1C), together weighing 330g. Data were averaged over three time-normalised gait cycles per condition, per subject. Spatiotemporal and sagittal plane kinematic hip, knee and ankle data were compared between conditions using paired t-tests and SPM one-way repeated measures ANOVA ($\alpha = 0.05$). Semi-automatic MTJ-tracking software was used to quantify muscle, tendon and muscle-tendon-unit length change relative to length at initial contact [2].

Results

SMG had no significant effects on the spatiotemporal or kinematic data in persons post-stroke and healthy controls (Figure1A). Walking speed differed between post-stroke and control subjects (0.6 $\pm$0.3 vs. 1.1$\pm$0.3m/s, $p < 0.004$). Corresponding with a smaller ankle range of motion and increased knee flexion, the relative MTU length change during the stance phase (Figure1B) was, on average, lower post-stroke (+17mm) compared to control (+25mm). In both groups, the tendon aided in lengthening the MTU during midstance. The muscle length changed minimally over the entire gait cycle in stroke (4mm) compared to control (16mm), indicative of post-stroke GM paresis.

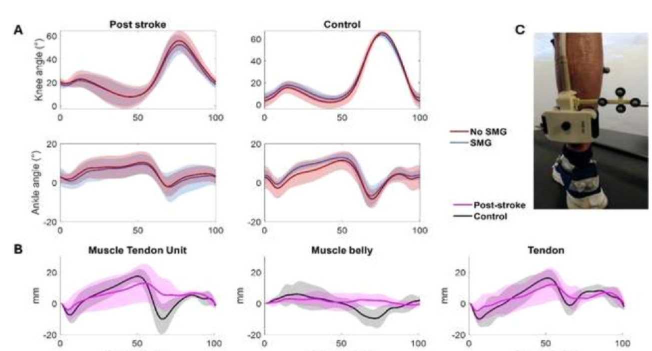

Figure 1. A) Sagittal-plane kinematics with and without sonomyography (SMG). **B)** Relative gastrocnemius medialis length changes. **C)** Ultrasound as used during SMG.