Tibco Software Inc, Palo Alto, USA). The differences between limbs were compared by paired t-test.

Results

Postural sway in were slightly bigger for landing compared to non-landing limb for both ML (landing: 8.1 mm, non-landing: 6.5 mm; p = 0.22) and AP (landing: 9.2 mm, non-landing: 8.6 mm; p = 0.53) directions, however the difference were not significant. Landing task showed slightly shorter TTS (landing: 1.33 s, non-landing: 1.41 s, p = 0.67) and smaller COP variability (landing: 4.56 mm, non-landing: 6.26 mm, p = 0.09) for landing limb, but also in this case there was no significant difference.

Discussion

Our results showed no significant difference between landing and non-landing limbs during both static and dynamic balance tasks in female figure skaters.

References

No references

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Predicting knee contact forces in walking: A comparative study of machine learning models including a physics-informed approach

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Introduction

Accurately predicting knee joint contact forces (KCF) is crucial for diagnosing and treating knee injuries and disorders [1]. In addition to clinical 3D gait analysis (3DGA), advanced musculoskeletal (MSK) models offer deeper insights in movement dynamics [2,3]. However, their requirement for specialized expertise, high computational resources, and time consumption limits their clinical utility [4]. Machine learning (ML) shows promise in estimating internal gait parameters, yet current approaches struggle with accuracy and generalizability due to typically small training datasets, limited to mostly healthy participants [4-7]. This study evaluates various ML models, i.e. Random Forest (RF), Multi-Layer Perceptron (MLP), and Long Short-Term Memory (LSTM) networks as well as a novel physics-informed variant of an LSTM (LSTMpi) network on a large-scale patient dataset, aiming to enhance KCF prediction accuracy and practicality.

Research Question

How accurately can ML models predict KCFs for the medial, lateral, and total compartments?

Methods

We used motion capture data from 822 patients with various frontal knee malalignments (male: 474, female: 348, age: 15.8 ±10.4), totaling 12,381 strides. Eleven time-normalized joint kinematics of the pelvis, hip, knee, and ankle joints served as the input for our ML models. KCFs obtained from musculoskeletal simulations were used as the ground truth [8-10]. The RF, MLP, and LSTM models were trained on 70% of the data, with hyperparameters tuned using a 10% validation set and evaluated on the remaining 20% test set. For the LSTMpi approach, we used a customized loss function with the physical constraint that the sum of the medial and lateral knee forces must equal the total KCF. To assess the performance of our models, we calculated the Normalized Root Mean Squared Error (NRMSE) for each trial by dividing each RMSE value by the (min-max % body weight).

Results

The results indicate that both LSTM models outperformed RF. The MLP also performed very well in terms of NRMSE. The LSTMpi performed comparably to the standard LSTM, achieving mean NRMSE values of 0.0603 ± 0.021 (Total KCF), 0.0755 ± 0.035 (Medial KCF), and 0.1237 ± 0.075 (Lateral KCF), see Figure 1.

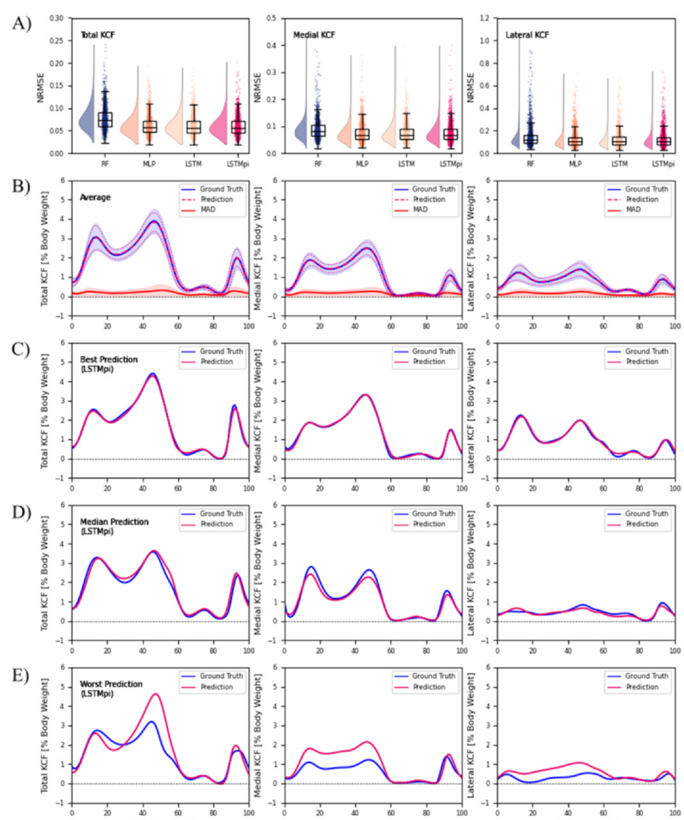

Figure 1: A) Raincloud-boxplots of the NRMSE for the four ML models. B) Averaged KCFs ± standard deviation and Mean Absolut Deviation (MAD) waveforms. C-E) Best, median, and worst KCF predictions.

Discussion

While current studies on this topic showed promising results, they were strongly limited in their generalizability due to their small-scaled datasets including mostly healthy controls [4-7]. Our results demonstrate that ML approaches can accurately estimate KCF on average, but still fail in a few single cases (e.g. Figure 1E). Our LSTMpi did not show any relevant advantage over a standard LSTM. One reason may be the simple physical constraint considered. In future research we will integrate more comprehensive physical models and investigate their effect on ML model convergence and prediction accuracy.

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Muscle thickness, muscle strength, and fitness in two young adults with moderate and severe spastic cerebral palsy

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Introduction

Spastic cerebral palsy (SCP) is a childhood onset disability affecting 2 to 3 per 1000 live births [1]. Although the initial brain injury is not progressive, muscle pathology, a leading sign in affected individuals, is an on-going process. Individuals with SCP are less physically active compared to their typically developing (TD) peers and the severely affected individuals are most sedentary [2,3]. Therefore, increased muscle wasting, decreased muscle function and cardiorespiratory fitness might be assumed in the latter group. However, the extent of muscle-tendon pathology as well as functional and cardiorespiratory limitations has still to be elucidated, particularly, since assessments in non-ambulatory individuals are difficult to perform.

Research Question

Do young adults with SCP and different functional limitations differ in terms of their muscle properties, isometric muscle strength, and cardiorespiratory fitness?

Methods

Within our ongoing project (Grant-DOI 10.55776/V992), two young adults with bilateral SCP (age: 23 and 25 years; Gross Motor Function Classification System (GMFCS) level: III and IV, respectively) and one TD women (age: 24 years) were investigated. Muscle thickness of the vastus lateralis (VL) and gastrocnemius medialis (GM) were examined within the more affected or non-dominant leg using 2D B-mode ultrasound, respectively. Moreover, isometric strength tests were performed to assess the knee extensors and flexors as well as the plantar flexors. Furthermore, cardiorespiratory fitness was determined using the 6-Minute Frame Running Test (i.e., peak heart rate (HRpeak), distance) combined with gas exchange assessments (peak oxygen uptake (O2peak)).