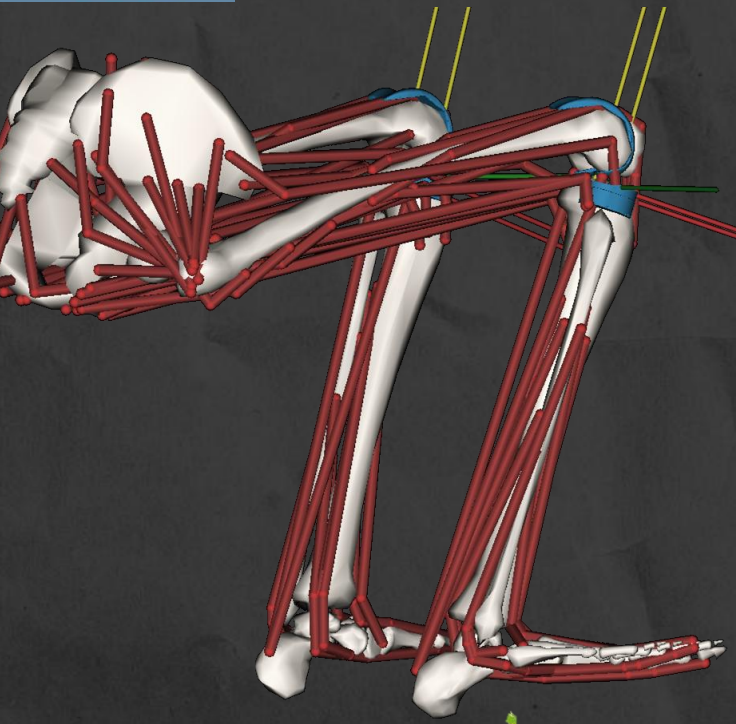
XX CBBauru 2023



COMPARISON BETWEEN INVERSE AND DIRECT APROACHS TO CALCULATE LOWER LIMB KINEMATICS AND KINETICS

Bruno L. S. Bedo[1,2]; Danilo S. Catelli[3];
Paulo R. P. Santiago[4]; Mario Lamontagne[2]

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[2] School of Human Kinetic - University of Ottawa, Human Mov., Biomech. Lab., Canada

[3] KU Leuven, Department of Movement Sciences, Human Mov. Biomec. Research Group, Belgium

[4] School of Physical Education and Sport of Ribeirão Preto – University of São Paulo, Brazil

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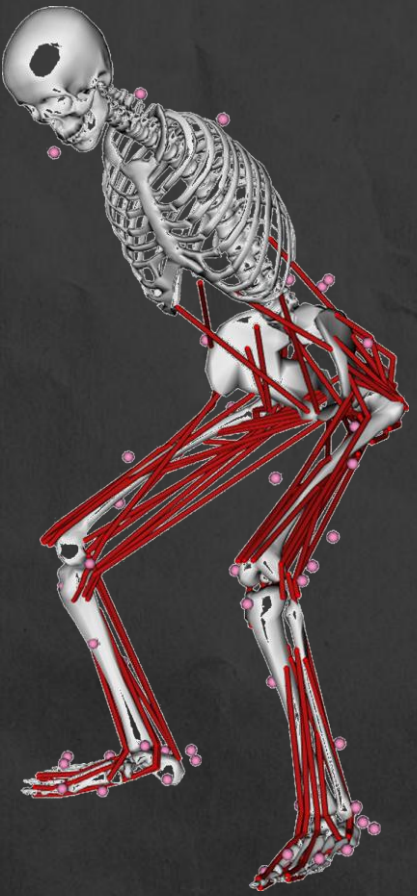
01

INTRODUCTION

Musculoskeletal models (MSKM) provide a non-invasive mechanism to investigate human movement and predict the effect of interventions on different tasks

INTRODUCTION



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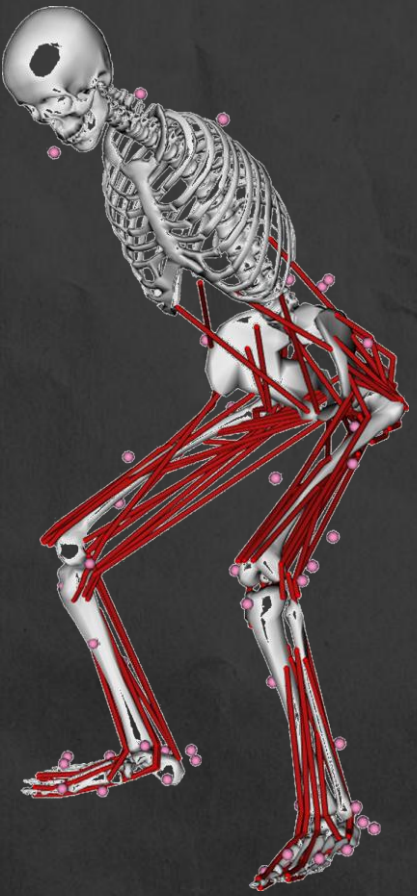
(Delp, et. al. 2007)

INTRODUCTION



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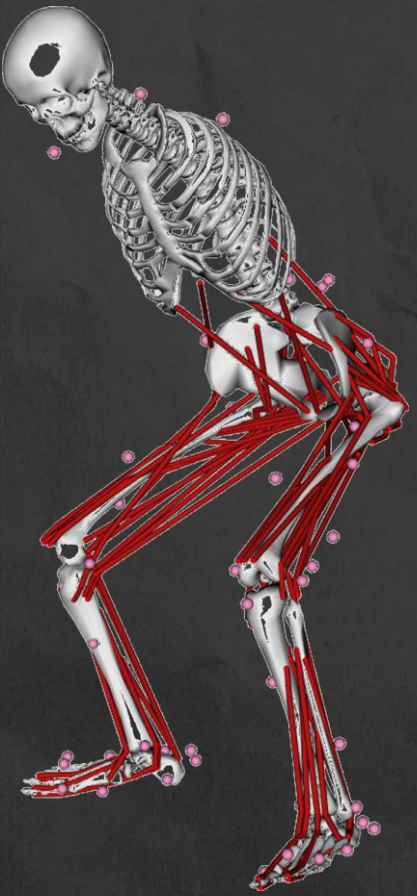
Most of the lower limb MSKM are designed and validated for tasks with restricted range of motion (ROM) such as walking and running;

(Bedo, et. al. 2020)

INTRODUCTION



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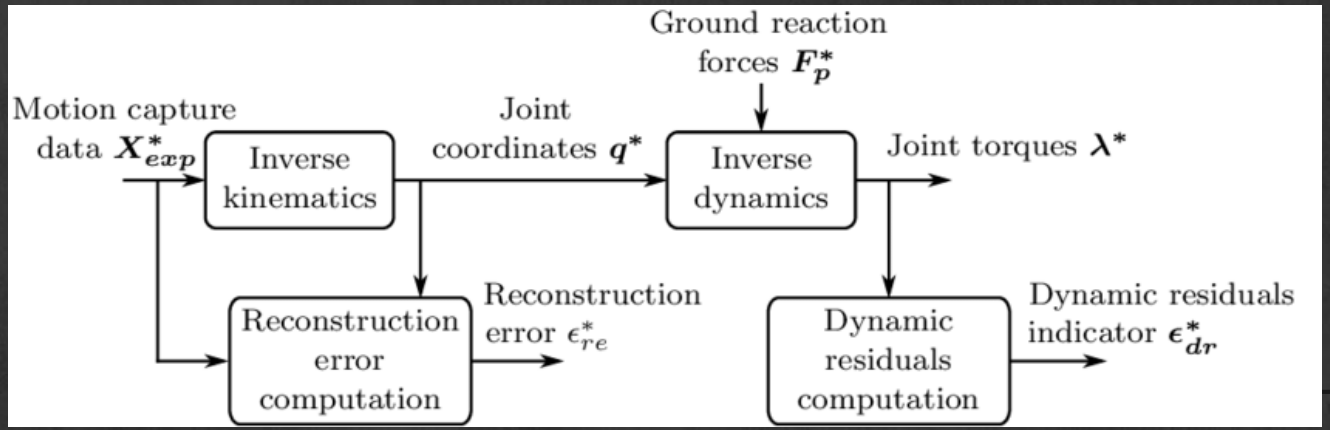
Most of the lower limb MSKM are designed and validated for tasks with restricted range of motion (ROM) such as walking and running; (Bedo, et. al. 2020)

Movements with high ROM, ensuring the dependability of the kinematic and kinetic data generated by simulation and motion capture software is crucial to ensuring the reliability and accuracy of the resulting output data.

INTRODUCTION

Direct kinematics: Joint kinematic parameters are calculated as Euler angles directly from 3D markers positions;

Inverse kinematics: Used in the most sophisticated musculoskeletal (MSK) models (e.g. OpenSim or Any-Body), also known as global optimization, to calculate joint angles.



02

PURPOSE

To compare the inverse and direct approaches to quantify knee and hip angles and moments during a task with a high range of motion.

03

METHODS

The local Human Research Ethics Committee granted ethical approval, and all participants signed a consent form before data collection

METHODS

SUBJECTS

Ten male without previous lower limb injuries

METHODS

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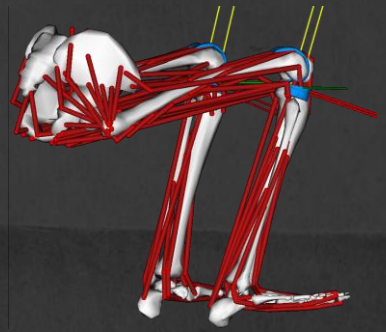
Ten male without previous lower limb injuries

TASK

Five deep squat trials at self-selected pace in a controlled position



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MOTION CAPTURE SYSTEM

45 full-body marker trajectories (200Hz) and two force plates (1000Hz)

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Labelled and filtered (zero-lag, 6Hz fourth-order Butterworth) using Nexus 2.6.1 (Vicon)

NEXUS

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DIRECT APROACH

University of Ottawa Motion Analysis Model (UOMAM) using Nexus System

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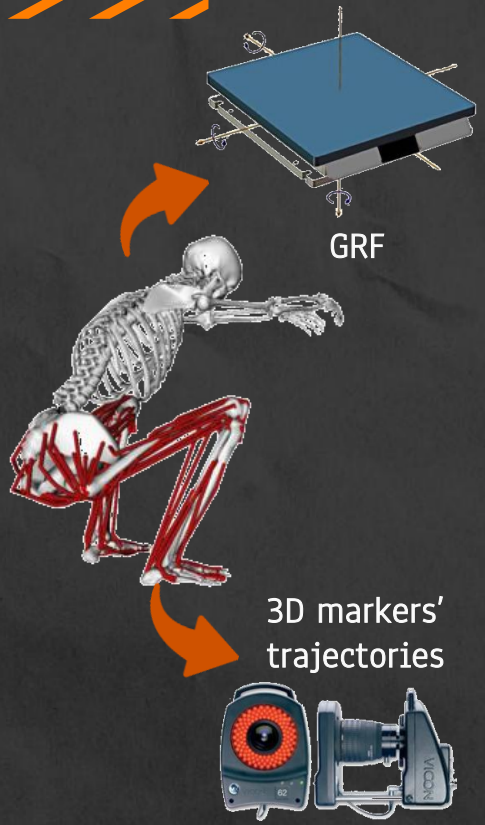
DIRECT APROACH

University of Ottawa Motion Analysis Model (UOMAM) using Nexus System

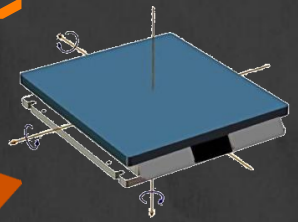
INVERSE APROACH

Inverse method was processed in OpenSim

METHODS



METHODS



GRF

3D markers' trajectories

VICON

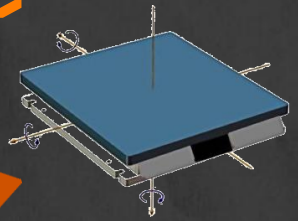
3D trajectories

Detection of events and preprocessing of trajectories in Vicon Nexus Software

.mot / .trc files

OpenSim

METHODS



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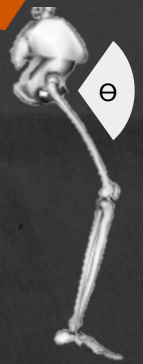
Direct kinematics



ID

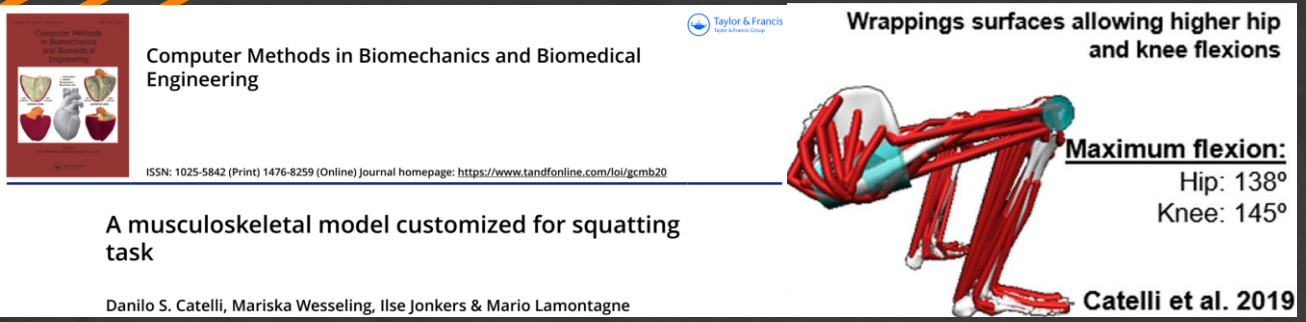
JOINT MOMENTS

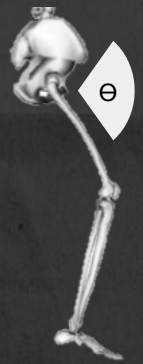
.mot / .trc files

OpenSim

Inverse kinematics

METHODS





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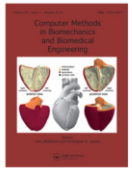


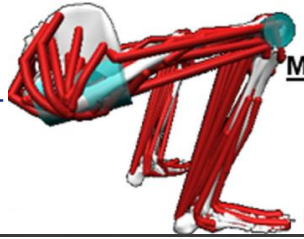
Computer Methods in Biomechanics and Biomedical Engineering

ISSN: 1025-5842 (Print) 1476-8259 (Online) Journal homepage: https://www.tandfonline.com/loi/gcmb20

A musculoskeletal model customized for squatting task

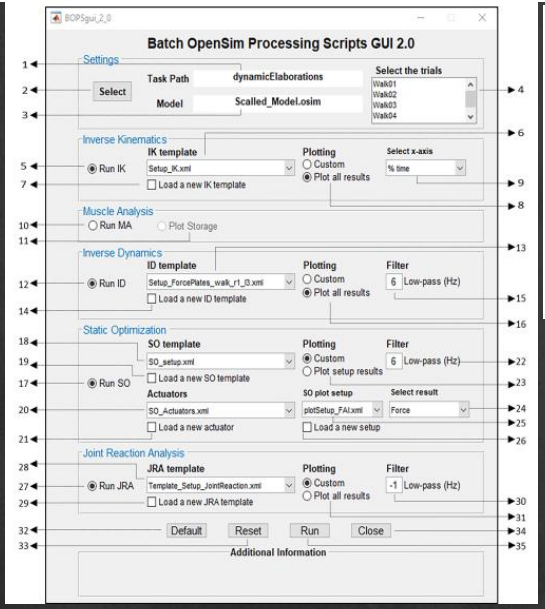
Danilo S. Catelli, Mariska Wesseling, Ilse Jonkers & Mario Lamontagne

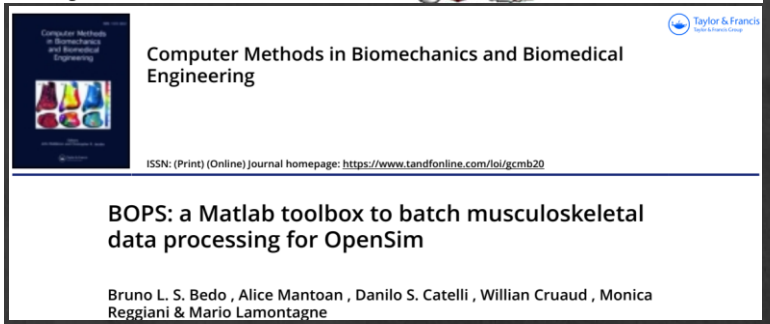
Wrappings surfaces allowing higher hip and knee flexions



Maximum flexion:
Hip: 138º
Knee: 145º

Catelli et al. 2019





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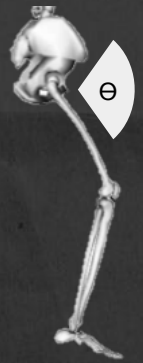
BOPS: a Matlab toolbox to batch musculoskeletal data processing for OpenSim

Bruno L. S. Bedo , Alice Mantoan , Danilo S. Catelli , Willian Cruaud , Monica Reggiani & Mario Lamontagne



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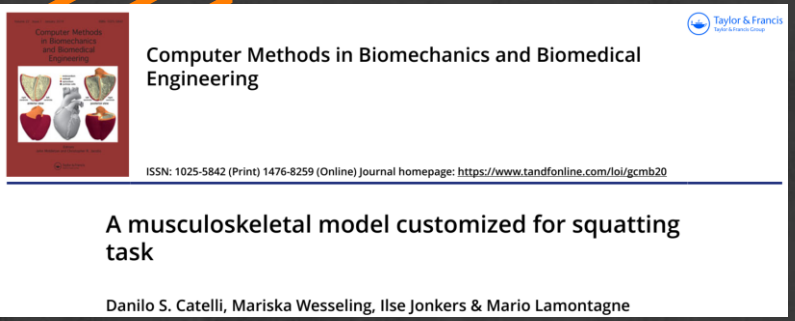

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The hip was analyzed on sagittal, frontal, and transverse planes, and the knee was analyzed on the sagittal plane

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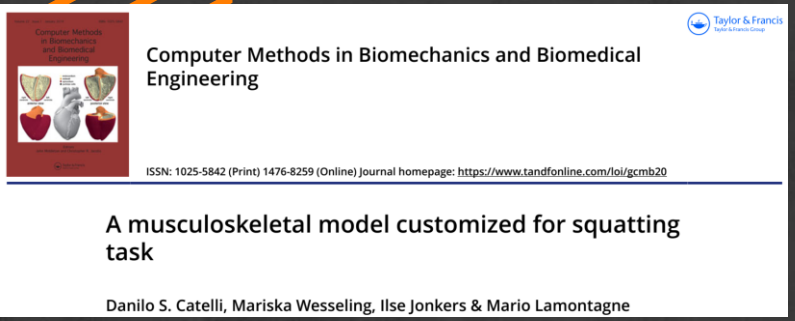

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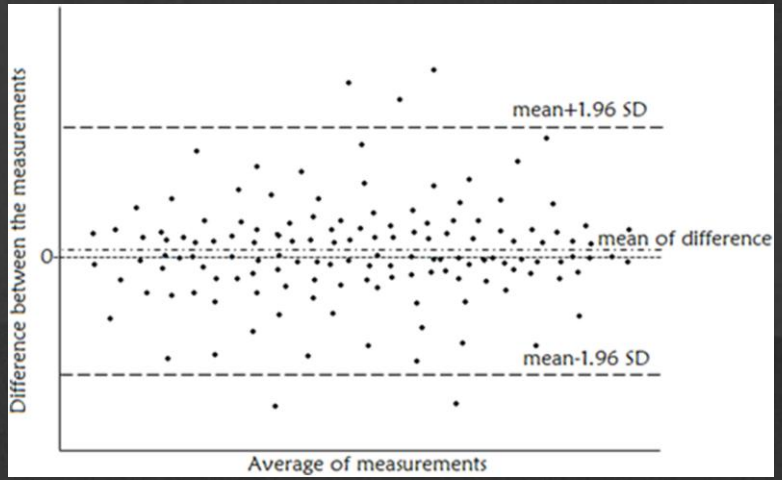


The degree of agreement between the two methods was assessed with Bland and Altman.

which is a statistical technique that plots means versus differences of measurements: if the means dispersion is within the 95% confidence limits, the measurements are in agreement

04

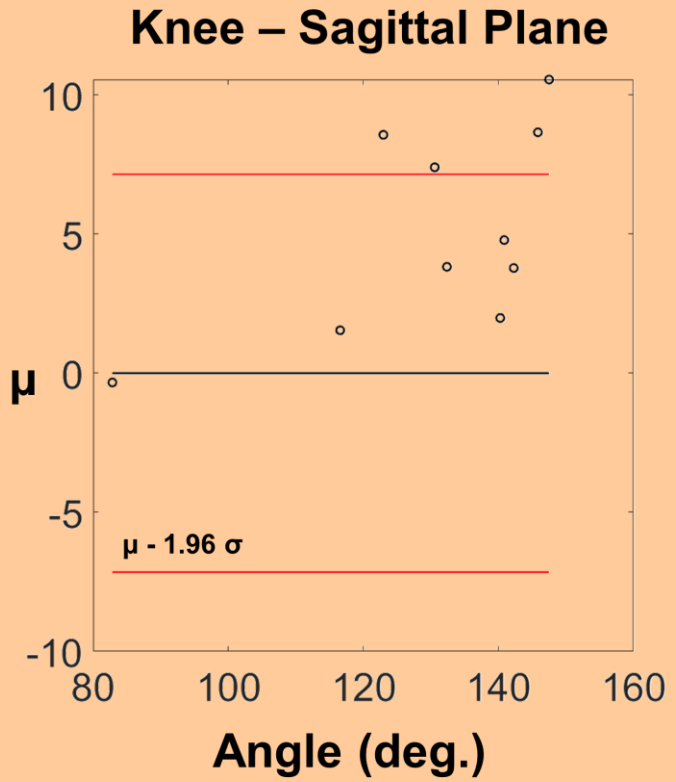
RESULTS

Bland-Altman plots applied to the peak joint angles or moments showed only partial agreement between the methods

kinematics

Tendency to measure higher knee flexion angles in Nexus than in OpenSim (133±21° and 128±18°, respectively)

RESULTS



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Tendency to measure higher knee flexion angles in Nexus than in OpenSim (133±21° and 128±18°, respectively)

The opposite happened for the hip flexion where the Nexus showed low values (106±7deg and 128±8deg, respectively

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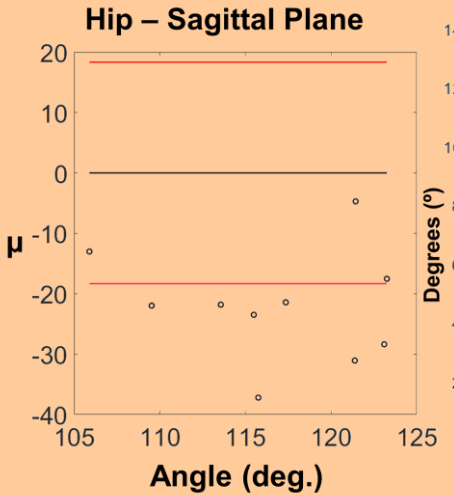

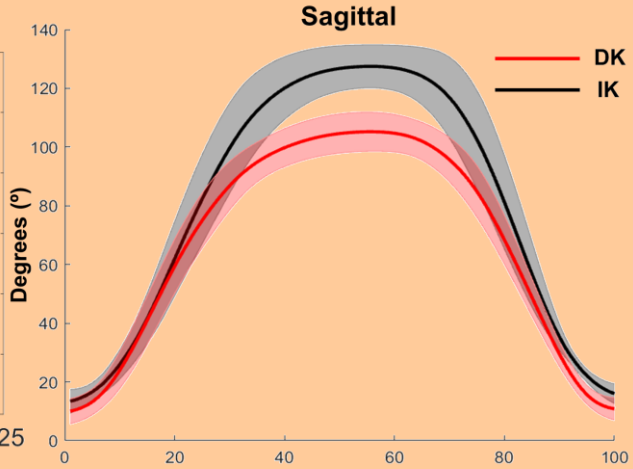

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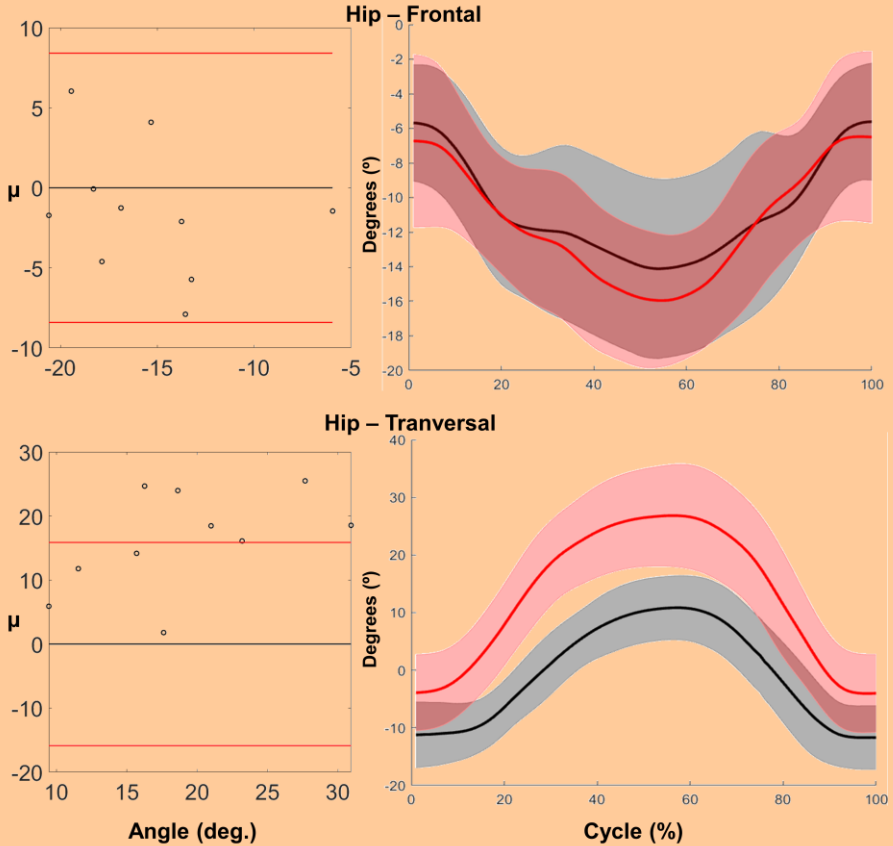

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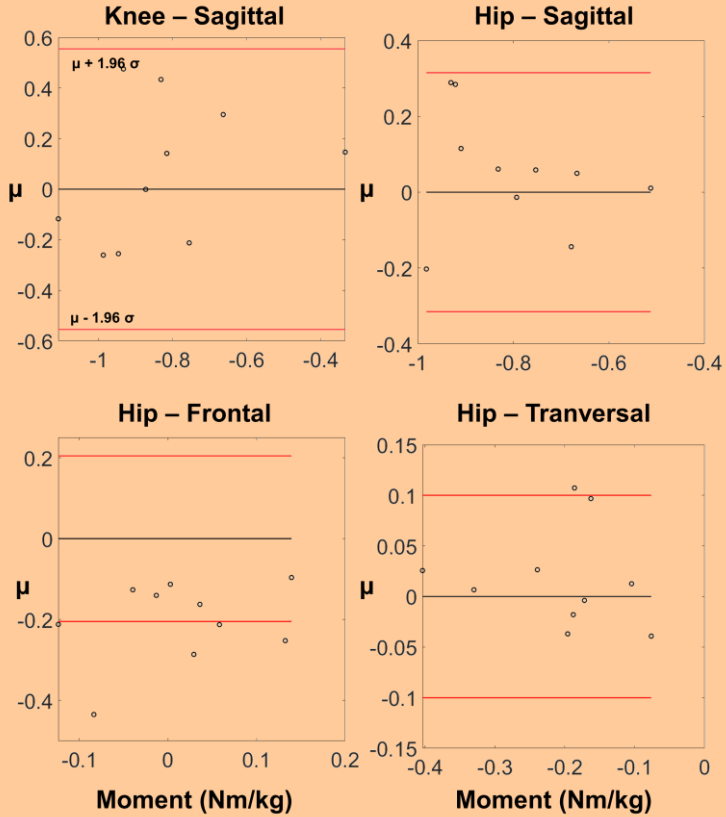
kinetics

Kinetic peak analyses showed good agreement between the methods in the sagittal plane for the knee and hip

There is a tendency for higher hip abduction in the OpenSim method (Nexus: -0.09±.11, OpenSim: 0.12±0.08)

RESULTS



05

CONCLUSION

Bland-Altman plots applied to the peak joint angles showed poor agreement regarding sagittal and transverse planes.

At the same time, the tests used for the typical peak moments showed good understanding, with its worst deal being on hip frontal moments.

THANKS!

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Do you have any questions or ideas?

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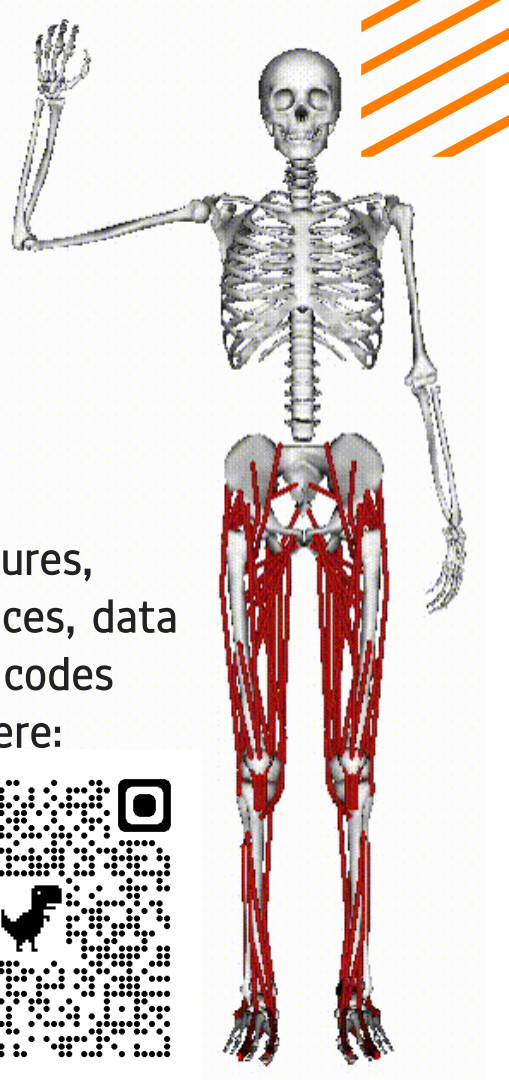

Figures, References, data and codes here: