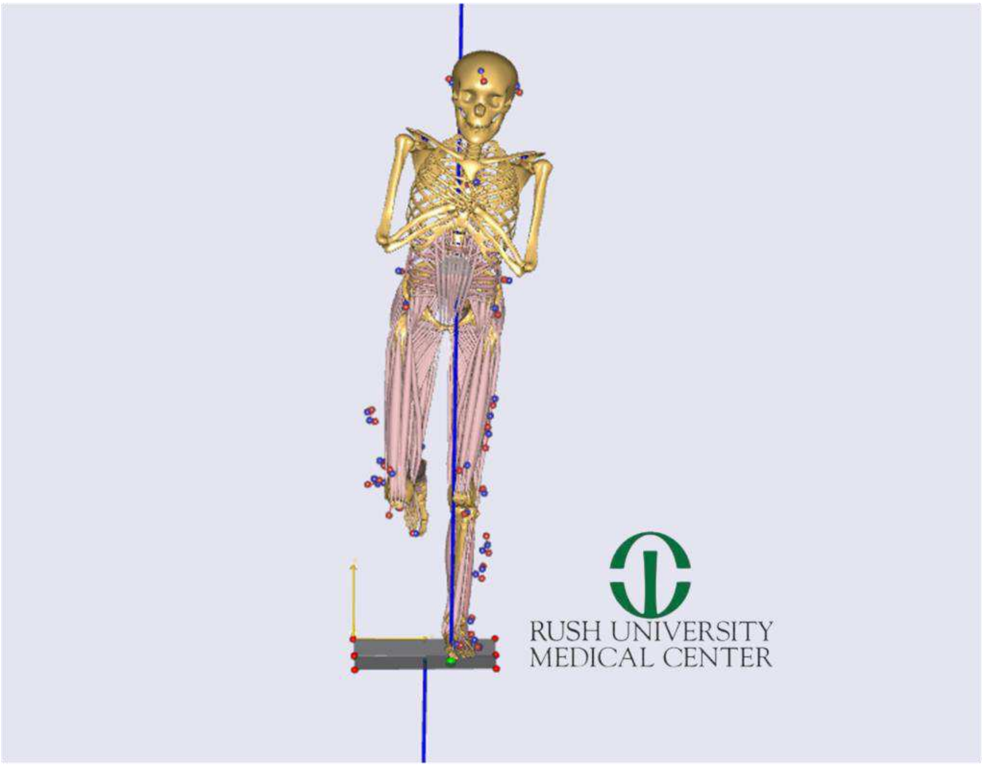
Marts 12, 2024

An analysis of hip joint contact forces in people with femoroacetabular impingement syndrome during squat task



The webcast will begin shortly…

Outline

- Introduction to the AnyBody Modeling System
- Presentation by Mattia Perrone
- Upcoming AnyBody events
- Question and answer session

Presenter

Mattia Perrone

Research Scientist

Rush University Medical Center

Host

Kristoffer Iversen

Technical Sales Executive

AnyBody Technology

Control Panel

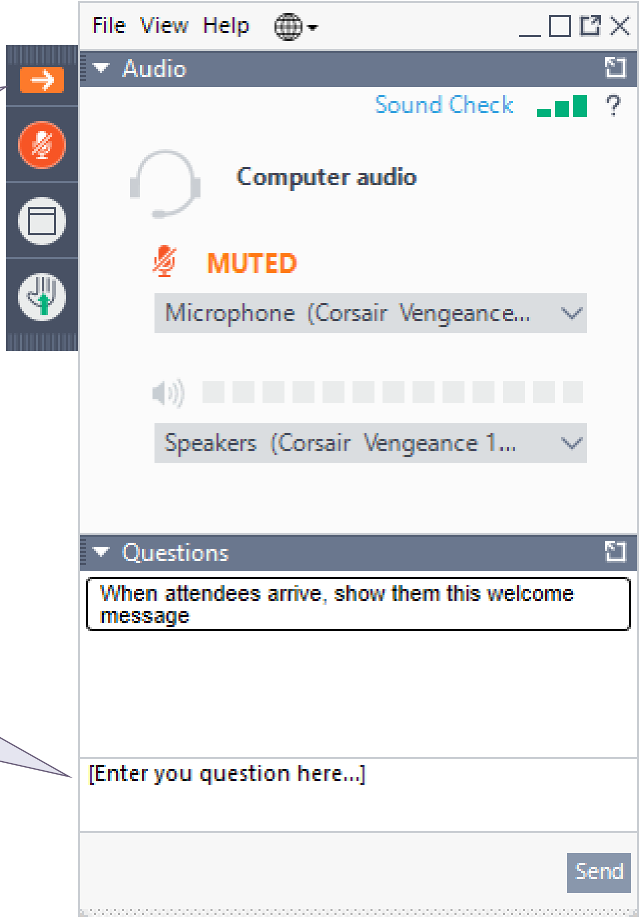
Expand/Collapse the Control Panel

The Control Panel appears on the right side of your screen.

Submit questions and comments via the Questions panel.

Questions will be addressed at the end of the presentation. If your question is not addressed, we will do so by email.

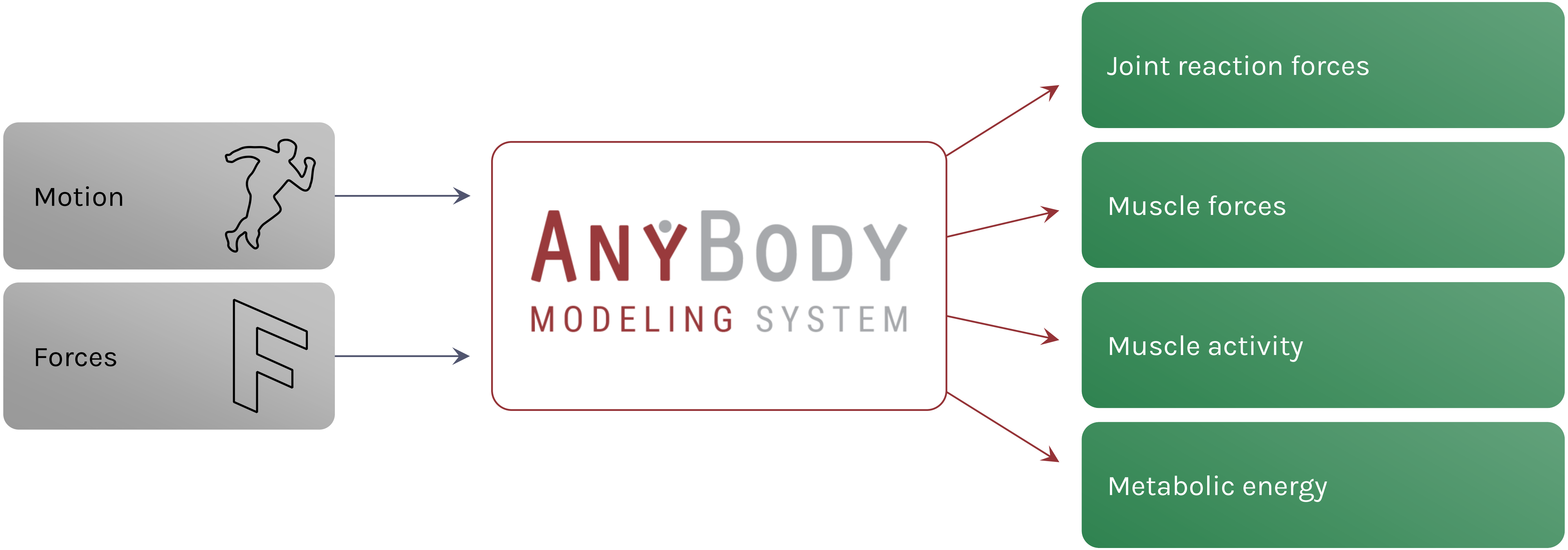
Ask a question during the presentation



Musculoskeletal simulations

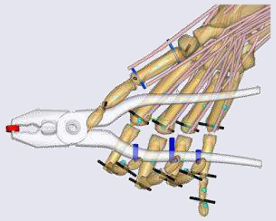
INPUT • Motion data

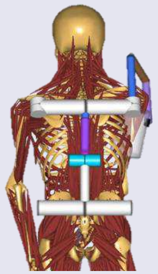
OUTPUT • Internal Body Loads



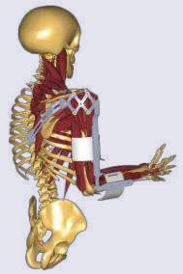
Motion analysis

Product design and optimization

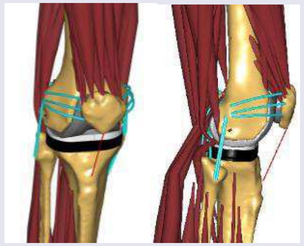




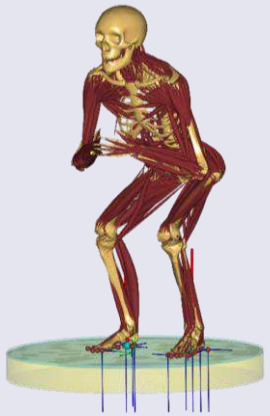
Ergonomics with/without exoskeletons



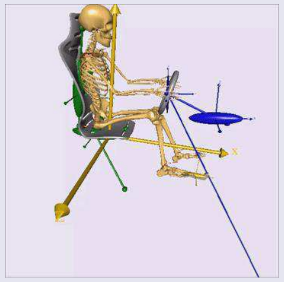
ANYBODY
MODELING SYSTEM



Orthopedics and Rehabilitation



Sports

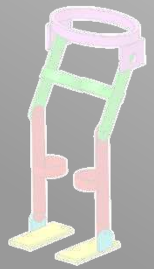


Automotive

Workflow

Motions and forces

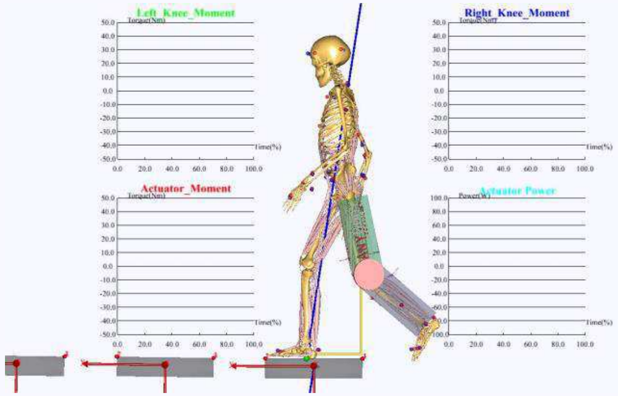
Body model



Environment model

Simulation

Inverse dynamics
Muscle recruitment

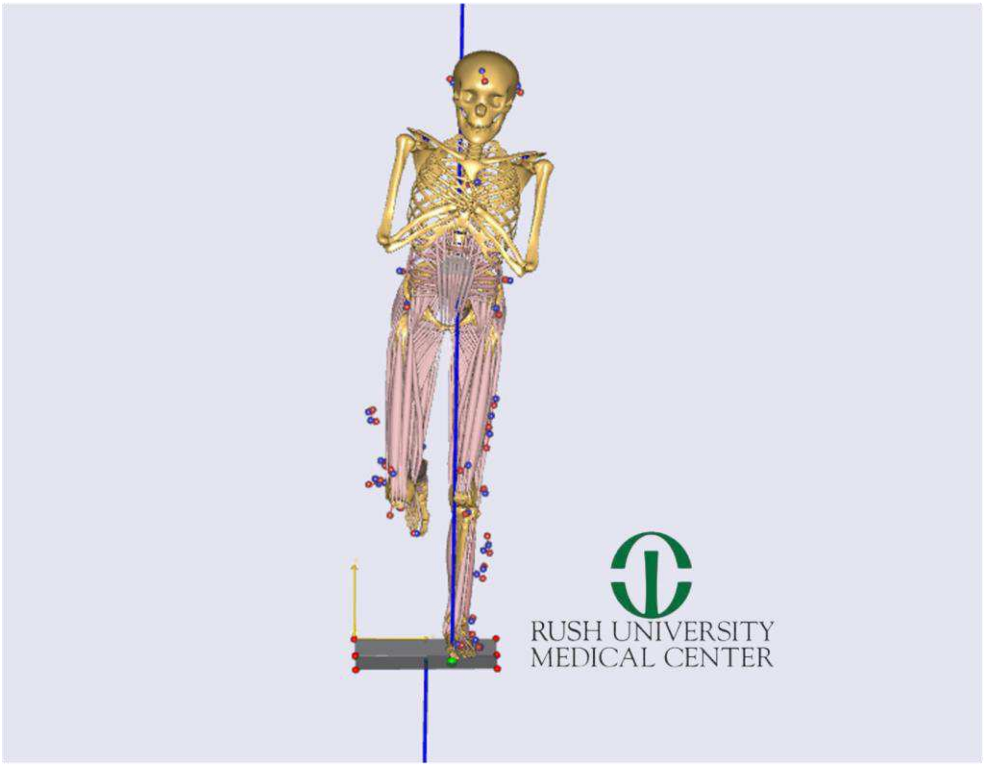


Internal body loads:
- Muscle forces
- Joint forces

Design Optimization

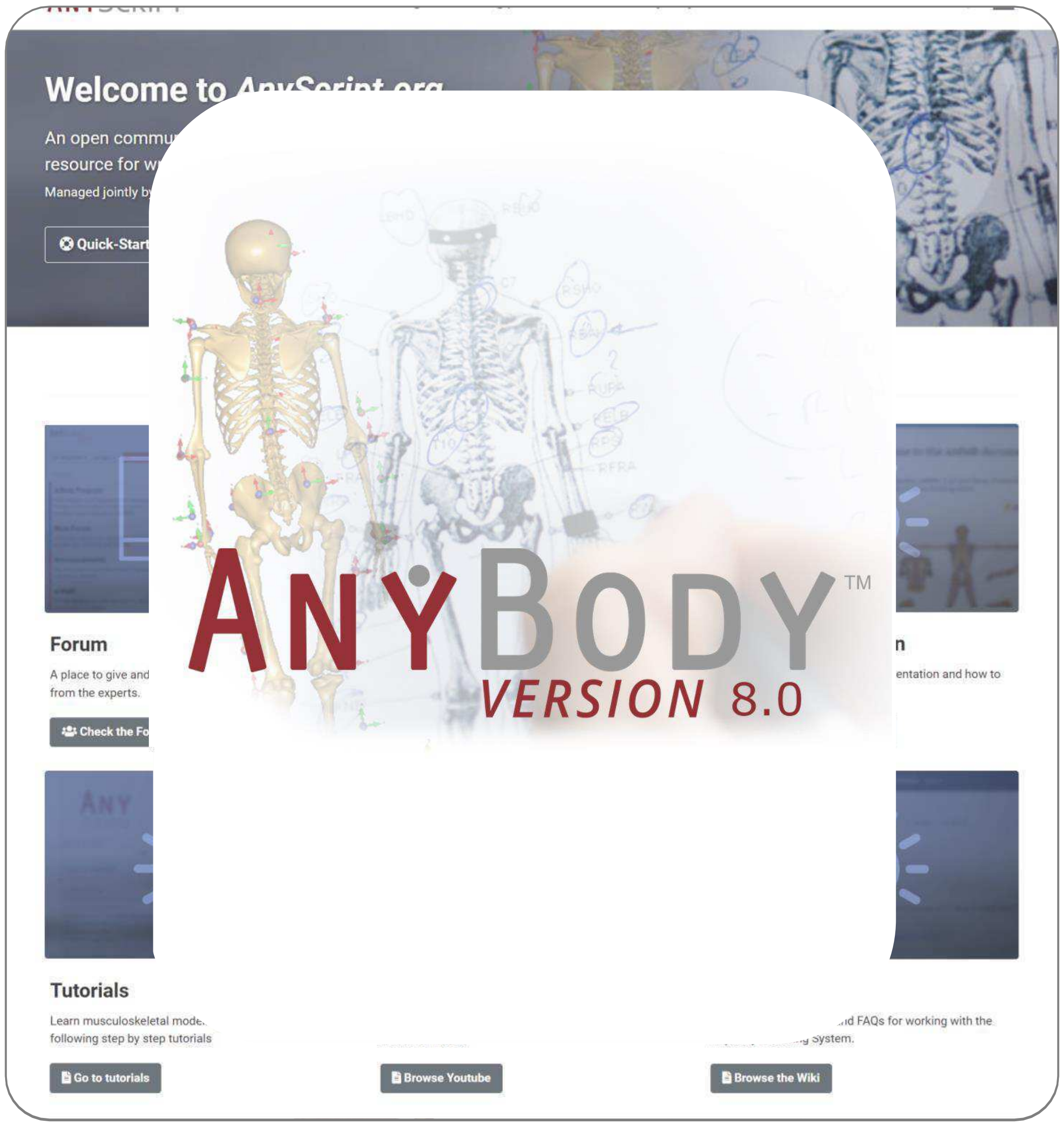
Post Processing
(e.g. Finite Element tools)

An analysis of hip joint contact forces in people with femoroacetabular impingement syndrome during squat task



Resources

- **www.anybodytech.com**
  - Events, Webcast library, Publication list, …
- **www.anyscript.org**
  - Wiki, Blog, Repositories, Forum
- **Events**
  - **Mar 21**: [Webcast] New features in the AnyBody Modeling System Version 8.0
    - Join us for a tour of the new AnyBody Modeling System 8.0 and the included updated AnyBody Managed Model Repository 3.0.



1000+

publications

filter by:

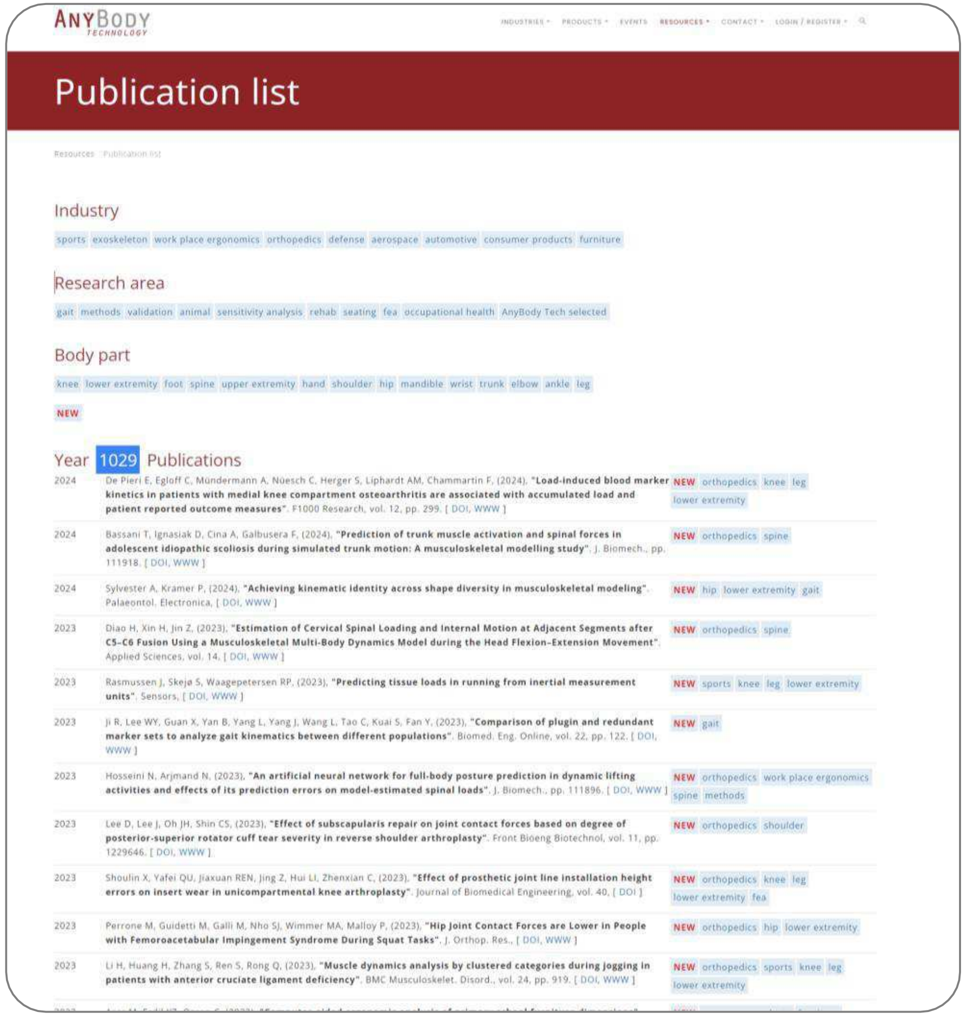
- Industry
- Research area
- Body part

100+

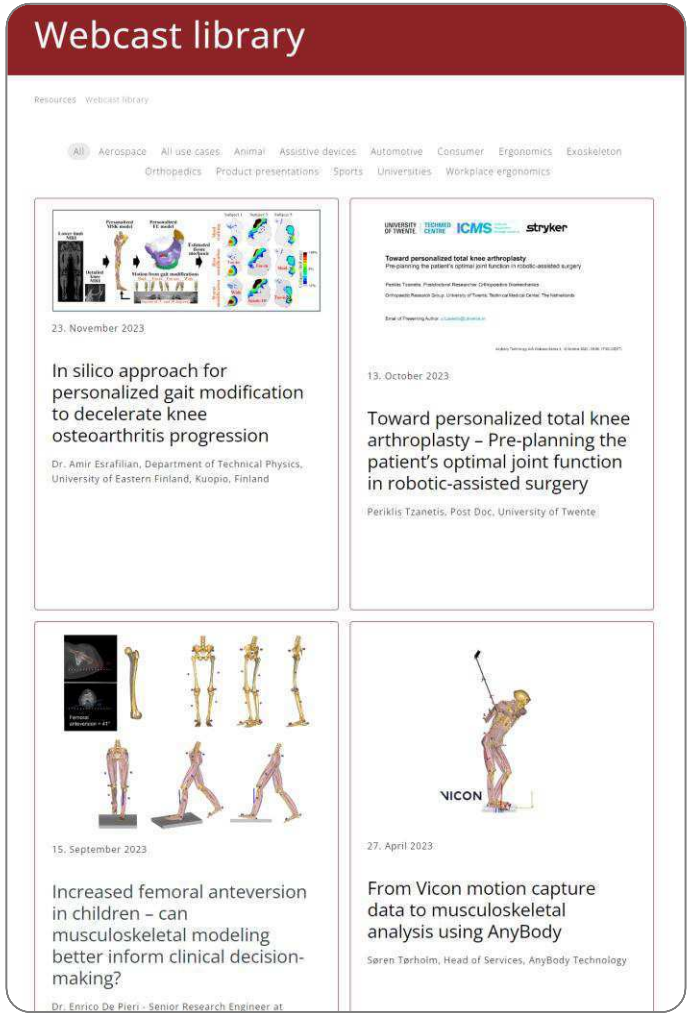
webcasts

filter by:

- Industry



[Publications list](#)



[Webcasts list](#)

Questions

Meet us

- Send email to sales@anybodytech.com

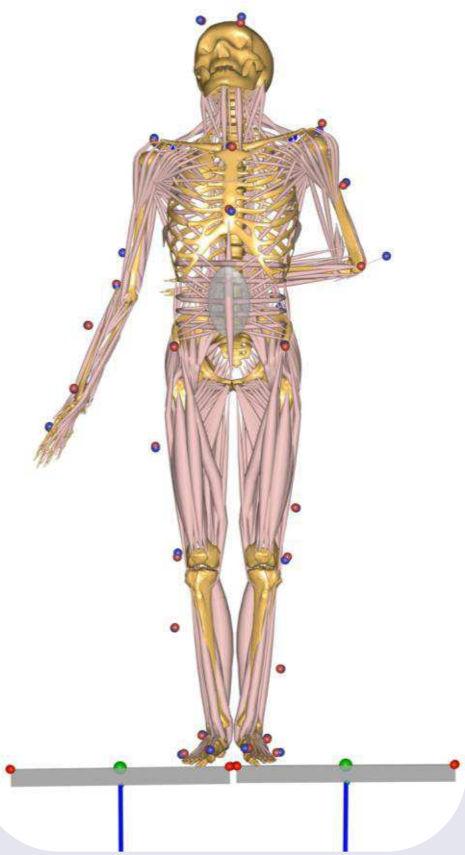
Trial version

- Send email to sales@anybodytech.com

Presentation questions

- Send email to ki@anybodytech.com

Thank you for your attention!



An Analysis of Hip Joint Contact Forces in People with Femoroacetabular Impingement Syndrome during Squat Tasks

Mattia Perrone[1,2,3,4], Martina Guidetti[1], Manuela Galli[3], Shane J. Nho[1], Markus Wimmer[1,2], Philip Malloy[1,4]

[1]Rush University Medical Center, Chicago, IL, [2]University of Illinois at Chicago, Chicago, IL, [3]Politecnico di Milano, Milan, Italy, [4]Arcadia University, Glenside, PA,

Disclosures: S.J.N. (CONMED Linvatec, OSSÜR, Allosource, Arthrex, DJ Orthopaedics, Athletico, Miomed, Smith & Nephew, Stryker), none of the other authors has anything to disclose.

RUSH UNIVERSITY MEDICAL CENTER

Outline

1. Background
2. Methods
3. Results
4. Discussions
5. Conclusions

Outline

1. **Background**
2. **Methods**
3. **Results**
4. **Discussions**
5. **Conclusions**

"Hip joint contact forces are lower in people with femoroacetabular impingement syndrome during squat tasks"

Journal of Orthopaedic Research

DOI: 10.1002/jor.25744

Affiliations

POLITECNICO
MILANO 1863

UIC

ARCADIA
UNIVERSITY
SINCE 1853

Background

Background

Femoroacetabular impingement syndrome (FAI)

- Hip condition: premature contact between the proximal femur and the acetabulum[1]

- Incidence of 20% in young athletes and active adults (US population)[1]

[1] Griffin DR, Dickenson EJ, O'donnell J, et al. The Warwick agreement on femoroacetabular impingement syndrome (FAI syndrome): an international consensus statement. Br J Sports Med. 2016;50: 1169-1176

Background

In vivo test

Background

In vivo test

In vitro test

Background

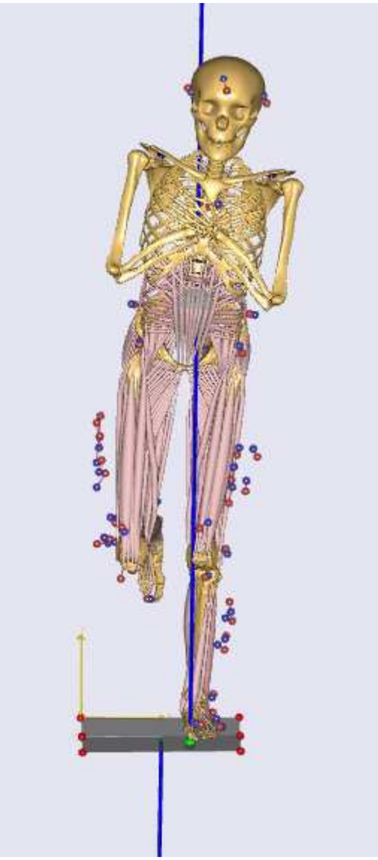
In vivo test

In vitro test

In silico test

Musculoskeletal Models

- Musculoskeletal (MSK) models include representations of bones, joints, ligaments and muscles



- Input data: kinematics and forces
- Output data: joint moments, muscle forces and joint forces

Literature on FAI - MSK models

Gait:

- Motion task most commonly investigated
- End of hip range of motion not involved
- Inconsistent results in the literature

Literature on FAI - MSK models

Gait:
- Motion task most commonly investigated
- End of hip range of motion not involved
- Inconsistent results in the literature

Double Leg Squat:
- Motion task less investigated than gait
- End of hip range of motion is reached
- Low forces at the hip

Literature on FAI - MSK models

Gait:
- Motion task most commonly investigated
- End of hip range of motion not involved
- Inconsistent results in the literature

Double Leg Squat:
- Motion task less investigated than gait
- End of hip range of motion is reached
- Low forces at the hip

Single Leg Squat:
- Motion task scarcely investigated
- End of hip range of motion is reached
- High forces at the hip

Aim of the Study

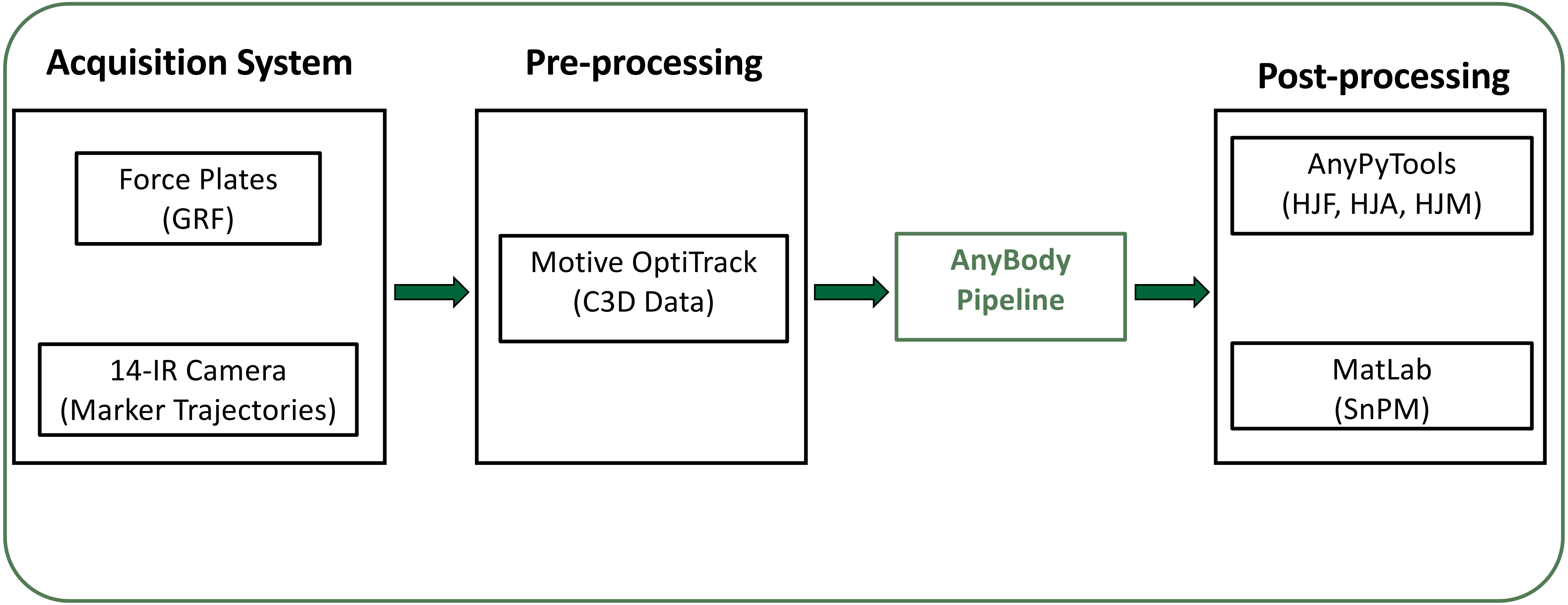
- Comparison of Hip Joint Forces (HJF) during gait, double leg squat and single leg squat between healthy controls and patients with FAI

- Comparison of HJF between healthy leg and injured leg in patients with FAI

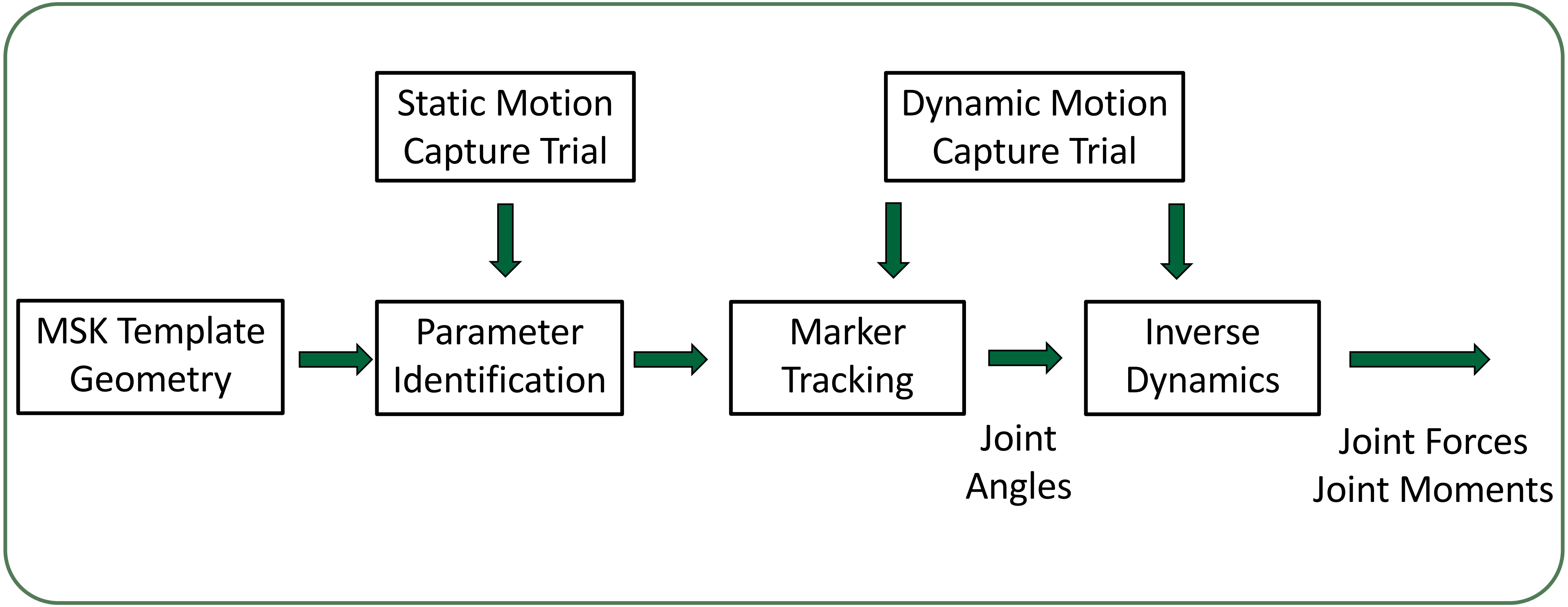
- It can be hypothesized that HJF will be lower in people with FAI

Methods

Motion Capture Pipeline



AnyBody Pipeline



MSK models in AnyBody

Model

Twente Lower Extremity Model
(TLEM-version 2.1)

Model Configuration Files

TrialSpecificData.any

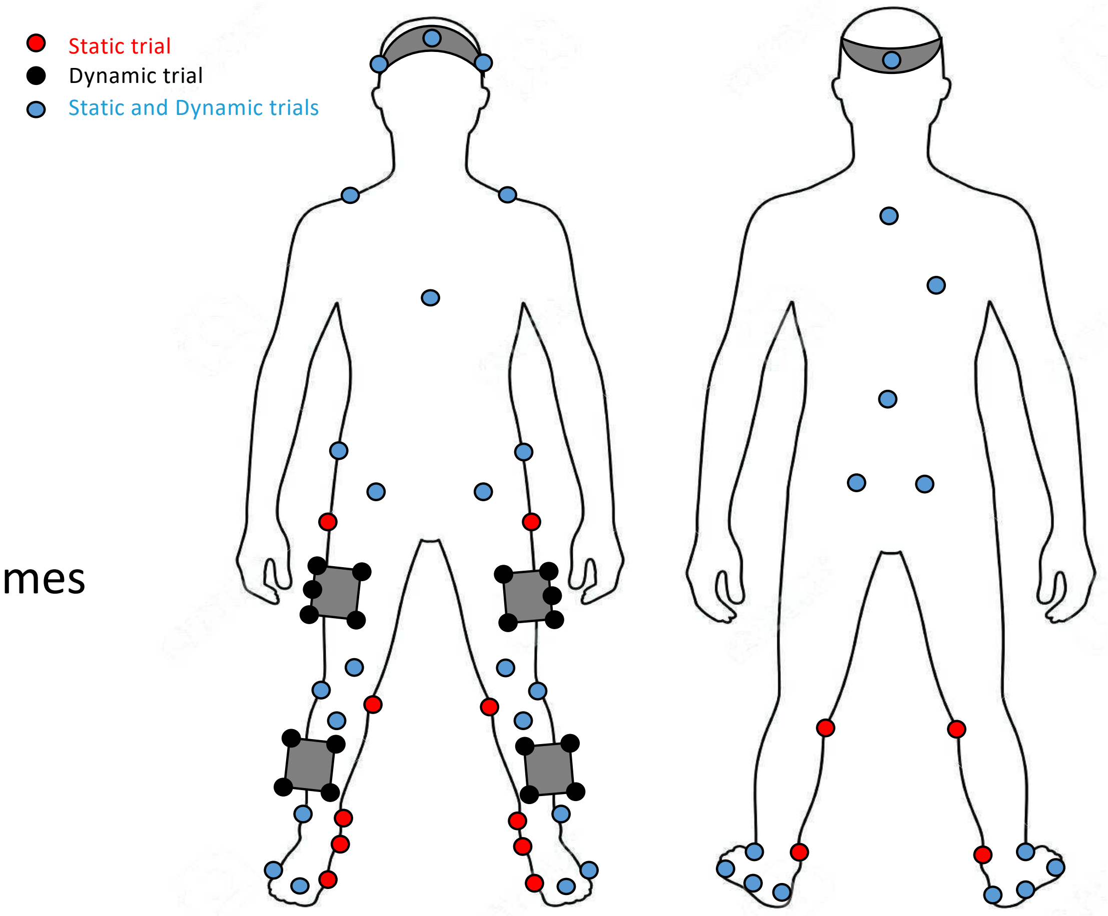
- Selection of the C3D file and its initial/final frames

SubjectSpecificData.any

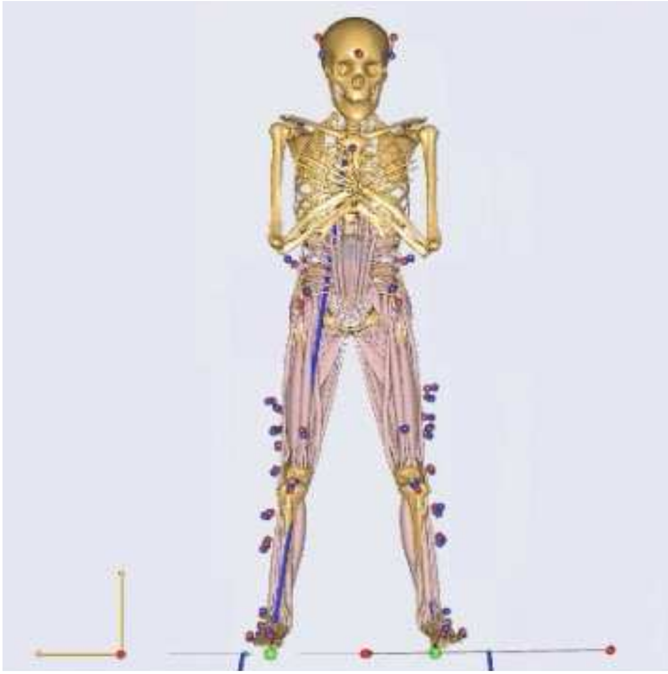
- Anthropometric data given in input

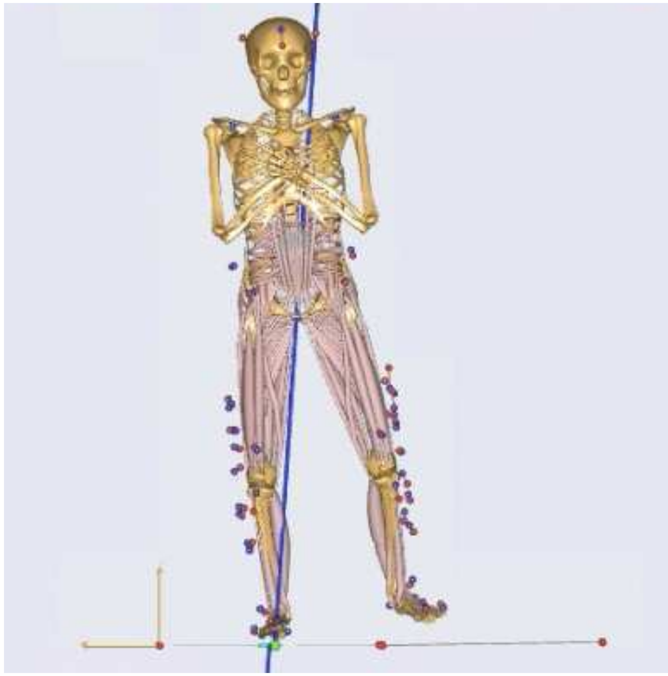
MarkerProtocol.any

- Marker protocol tuning



Motion Tasks Analyzed

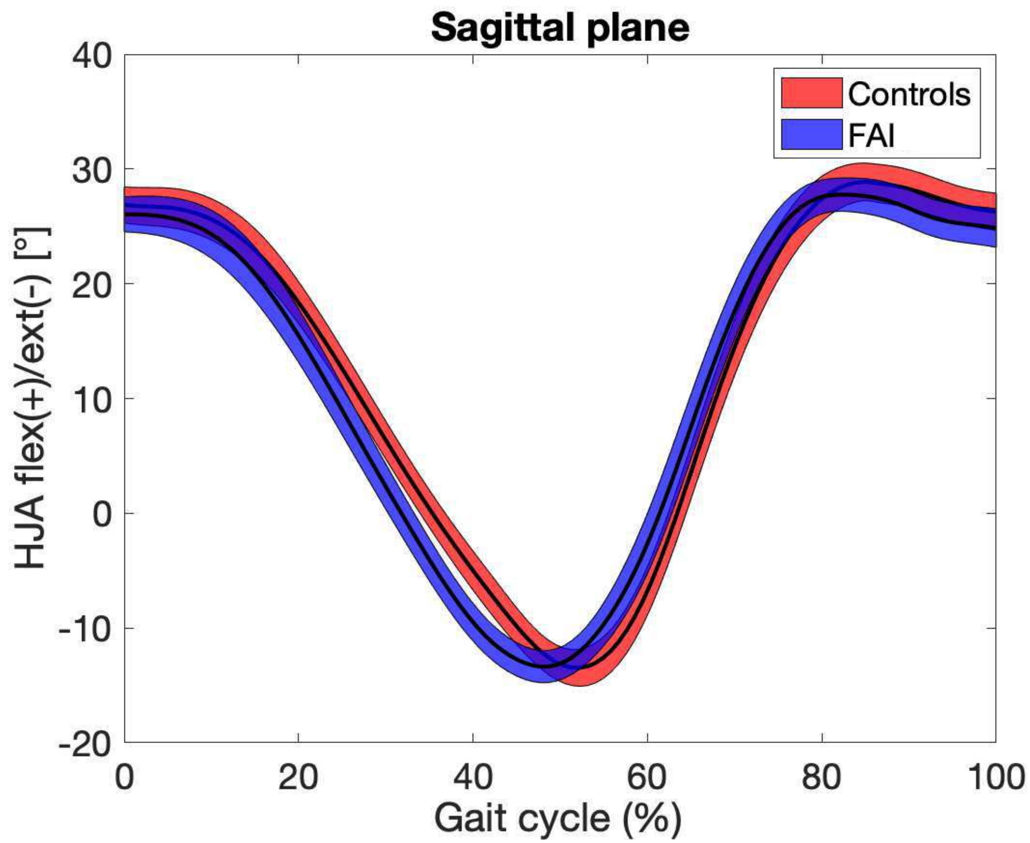


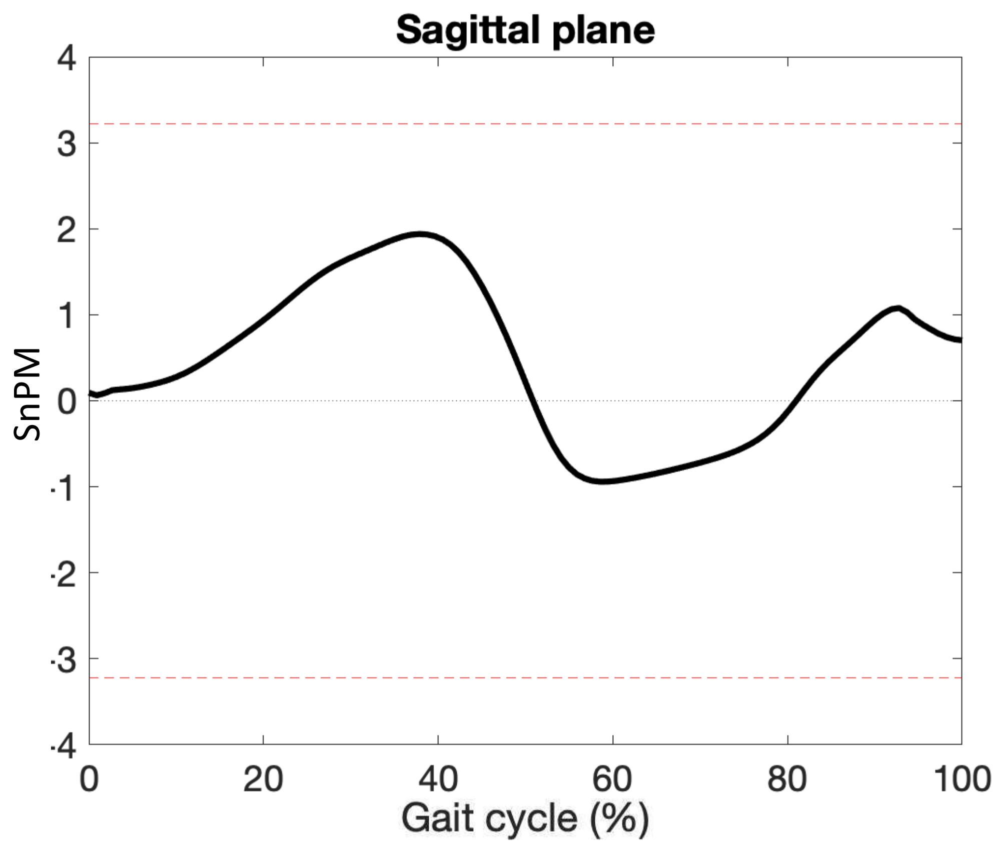


Gait	Double leg squat	Single leg squat
10 controls	10 controls	8 controls
10 patients with FAI	10 patients with FAI	8 patients with FAI

Results

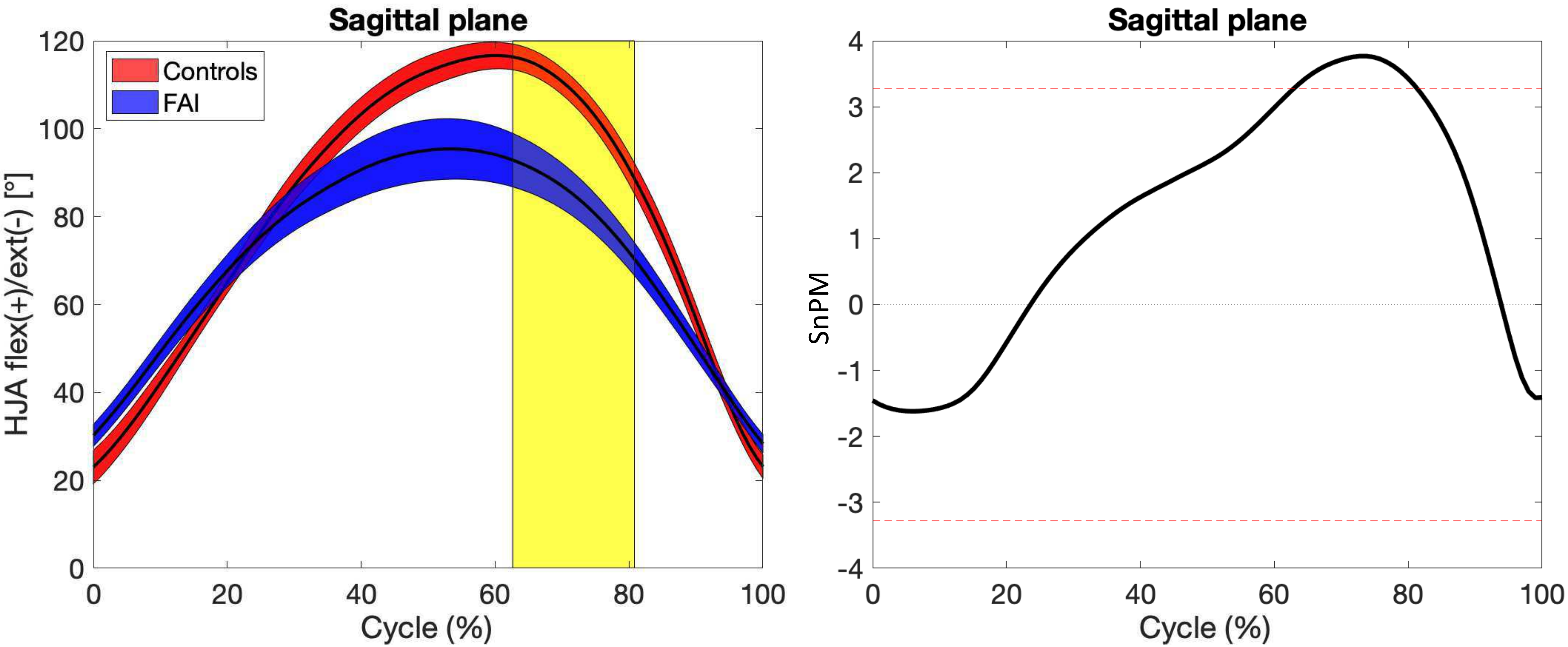
Results





RUSH UNIVERSITY
MEDICAL CENTER

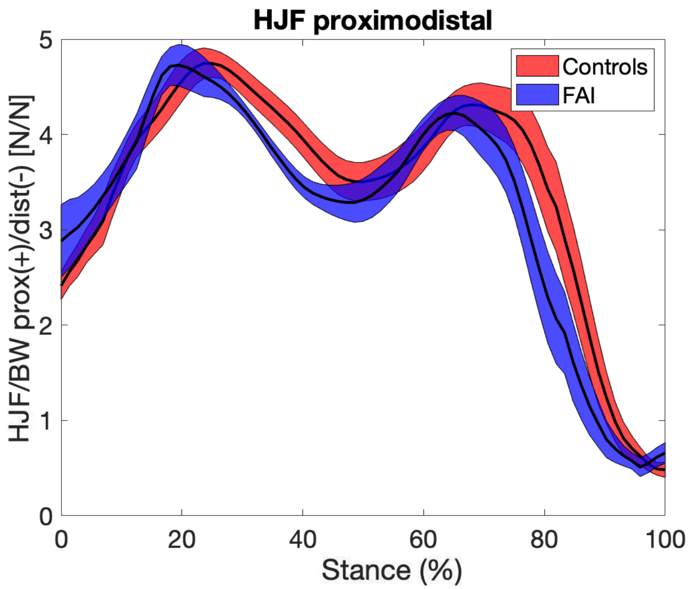
Results



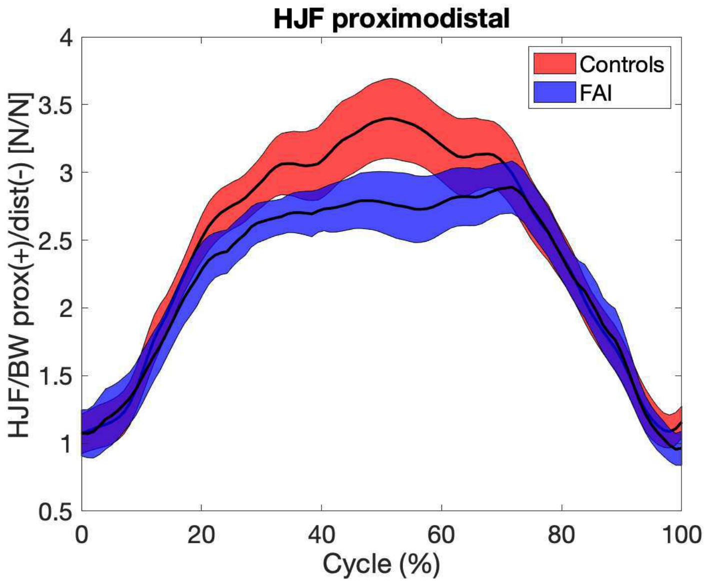
Sagittal plane
Controls
FAI
HJA flex(+)/ext(-) [°]
Cycle (%)
0
20
40
60
80
100
120
Sagittal plane
SnPM
Cycle (%)
4
3
2
1
0
-1
-2
-3
-4

Comparison of HJF during different tasks

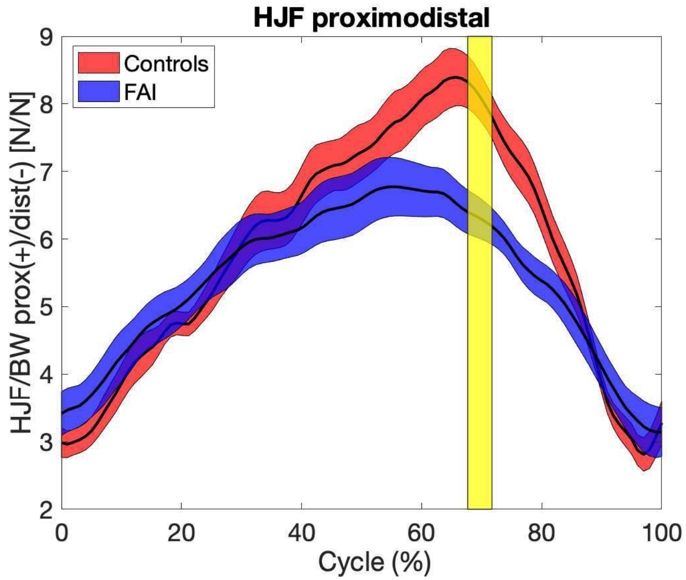
Gait



Double leg squat

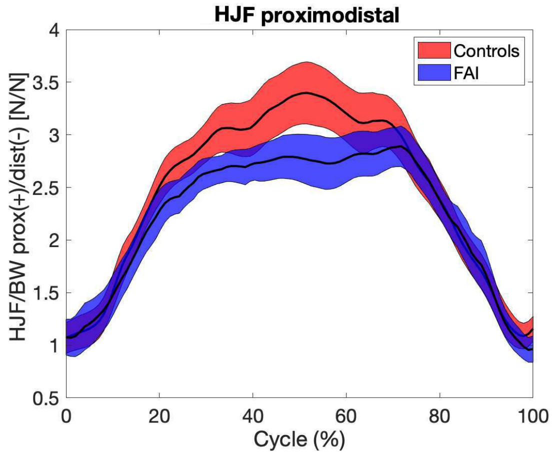


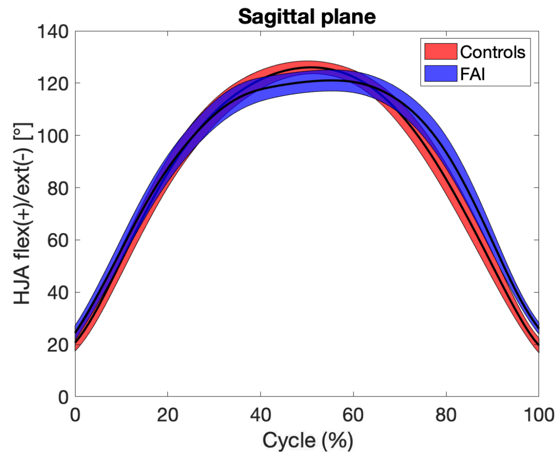
Single leg squat



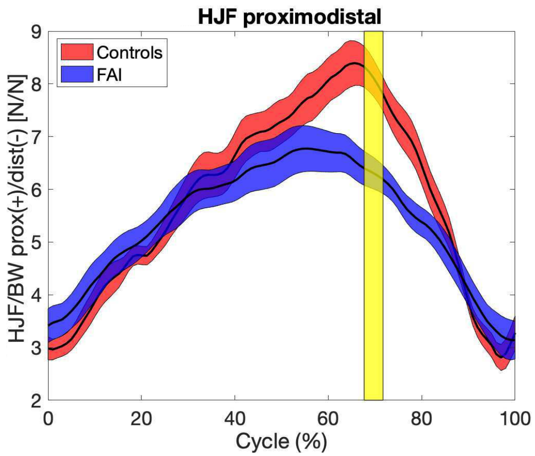
Comparison of HJA and HJF during different tasks

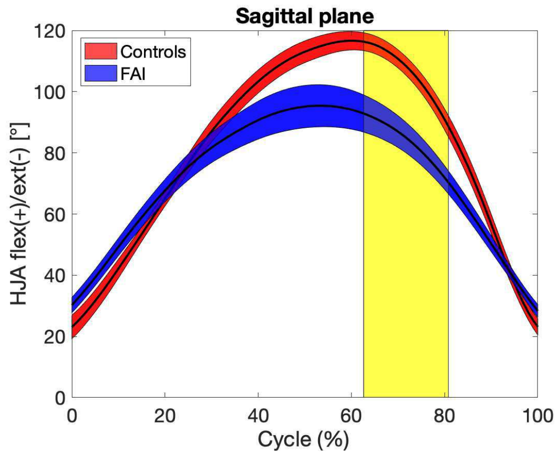
Double leg squat





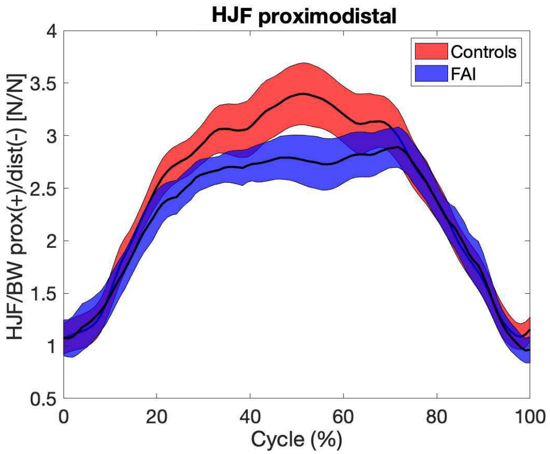
Single leg squat

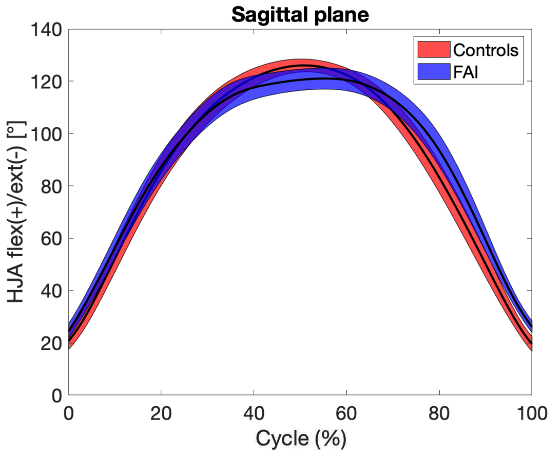




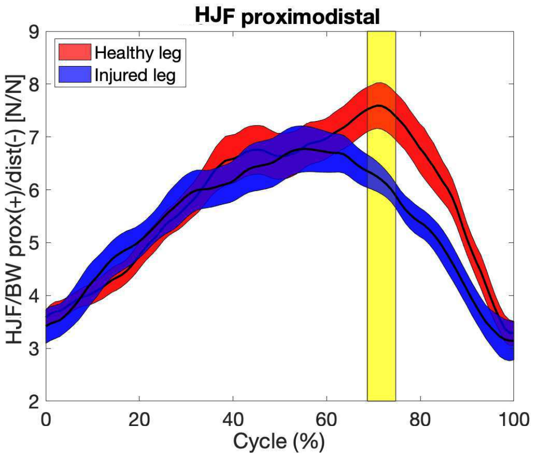
Comparison of HJA and HJF during different tasks

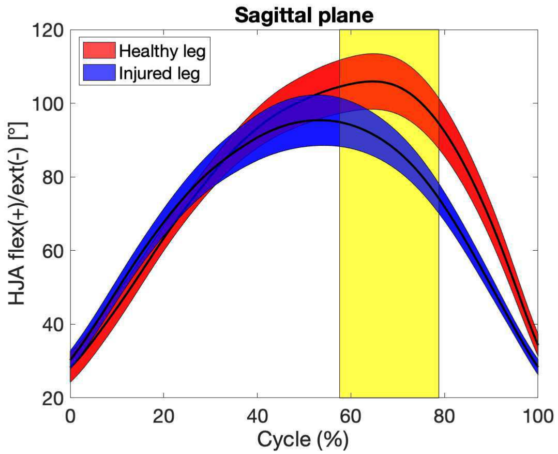
Double leg squat





Single leg squat





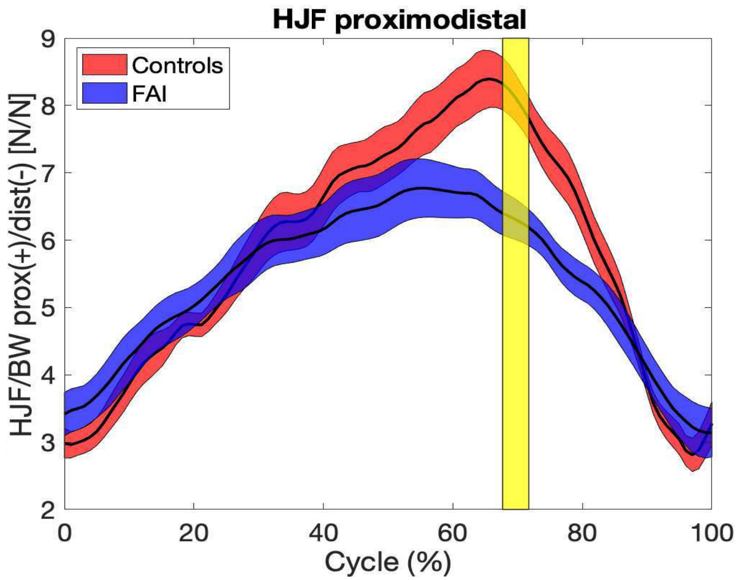
RUSH UNIVERSITY MEDICAL CENTER

Discussions

Main findings

- **Single leg squat:** Lower proximodistal HJF in patients with respect to controls

Strategy to avoid pain during this high demand task

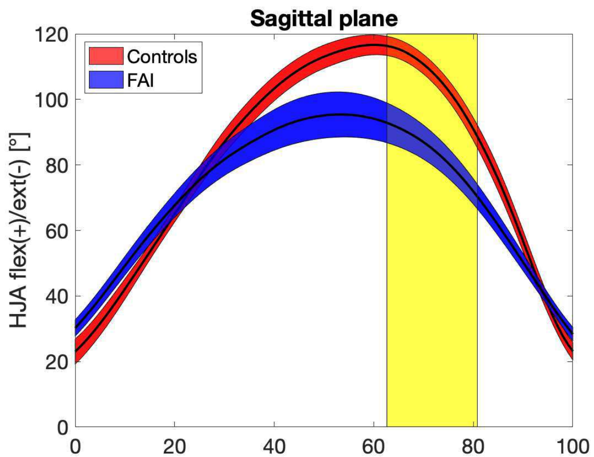


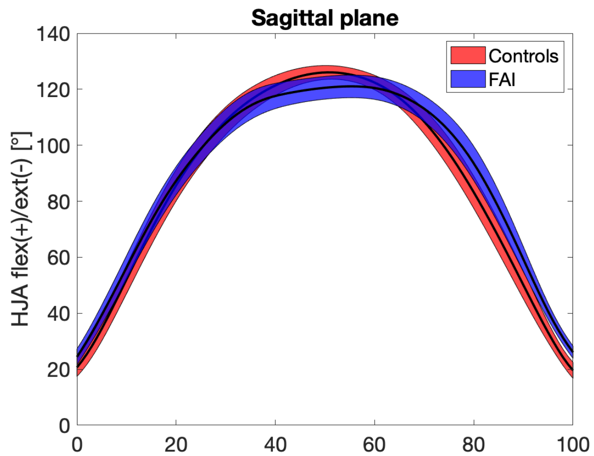
Main findings

- **Single leg squat:** Lower proximodistal HJF in patients with respect to controls → Strategy to avoid pain during this high demand task

- **Single leg squat:** Lower flexion HJA between patients and controls → Focus on proximodistal HJF when dealing with patients with FAI

- **Double leg squat:** No differences in terms of flexion HJA





Main findings

- **Single leg squat:** Lower proximodistal HJF in patients with respect to controls → Strategy to avoid pain during this high demand task

- **Single leg squat:** Lower flexion HJA between patients and controls
- **Double leg squat:** No differences in terms of flexion HJA

→ Focus on proximodistal HJF when dealing with patients with FAI

- **Gait** and **double leg squat:** No differences in terms of flexion HJA between patients and controls → Lower proximodistal HJF during these tasks

Conclusions

Conclusions

Background

- Femoroacetabular Impingement Syndrome
- Musculoskeletal models

Conclusions

Background

- Femoroacetabular Impingement Syndrome
- Musculoskeletal models

Methods

- Implementation of MSK models in AnyBody

Conclusions

Background

- Femoroacetabular Impingement Syndrome
- Musculoskeletal models

Methods

- Implementation of MSK models in AnyBody

Results and Discussion

- Lower proximodistal HJF for patients with FAI during single leg squat (high demand task)

Conclusions

Background

- Femoroacetabular Impingement Syndrome
- Musculoskeletal models

Methods

- Implementation of MSK models in AnyBody

Results and Discussion

- Lower proximodistal HJF for patients with FAI during single leg squat (high demand task)

Next steps

More complex MSK models can be implemented:

- Subject specific hip geometry from MRI reconstruction
- Analysis of hip muscles behaviors from EMG data

RUSH UNIVERSITY
MEDICAL CENTER