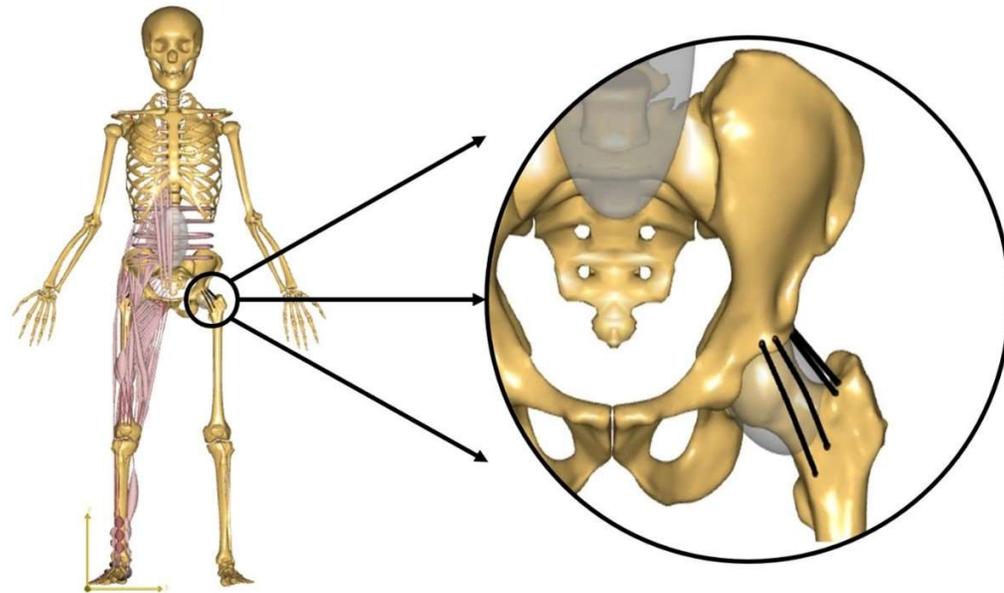


The webcast will begin shortly...

# The Role of The Anterior Hip Capsule In Daily Hip Performance

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May 5<sup>th</sup> , 2022



# Outline

- General introduction to the AnyBody Modeling System
- Presentation by Kate Duquesne

• Duquesne K, Pattyn C, Vanderstraeten B, Audenaert EA. **Handle With Care: The Anterior Hip Capsule Plays a Key Role in Daily Hip Performance.** Orthopaedic Journal of Sports Medicine. March 2022. doi:10.1177/23259671221078254



**Presenter:**

Kate Duquesne  
Doctoral Researcher

Department of Human Structure and Repair, University of Ghent



- Upcoming events
- Question and answer session



**Host(s):**

Bjørn Keller Engelund  
R&D Engineer

Kristoffer Iversen  
Technical Sales Executive

# Control Panel

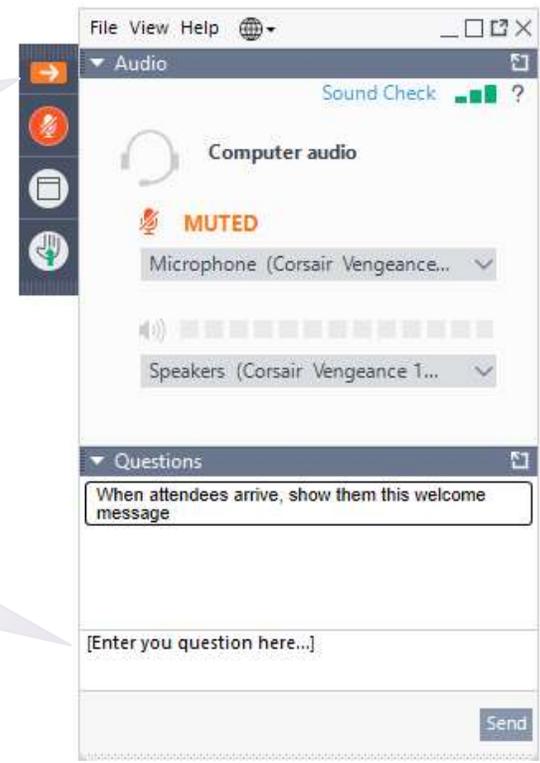
The Control Panel appears on the right side of your screen.

Submit questions and comments via the Questions panel.

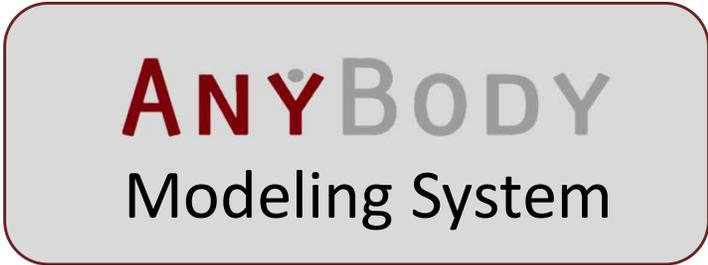
*Questions will be addressed at the end of the presentation. If your question is not addressed, we will do so by email.*

Expand/Collapse the Control Panel

Ask a question during the presentation



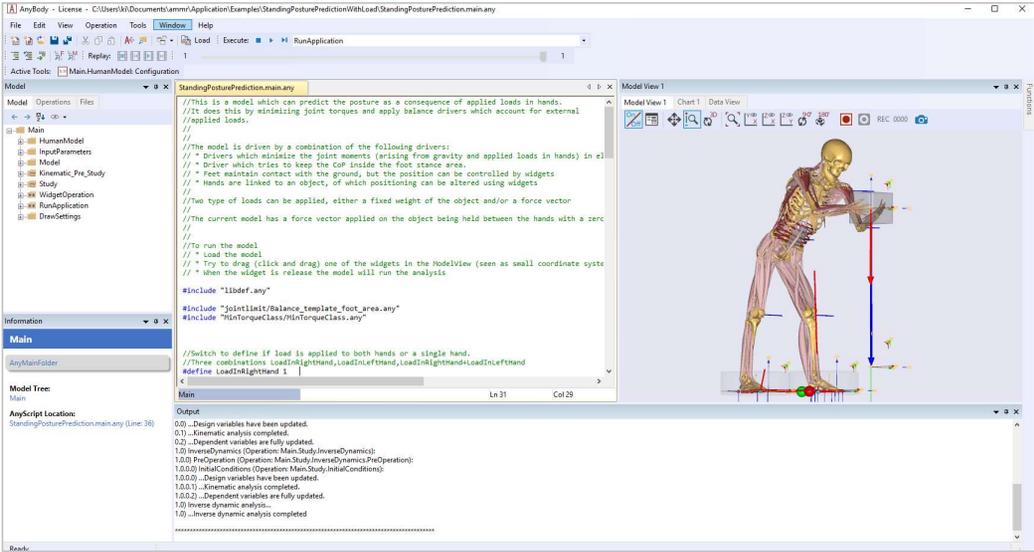
# Musculoskeletal Simulation



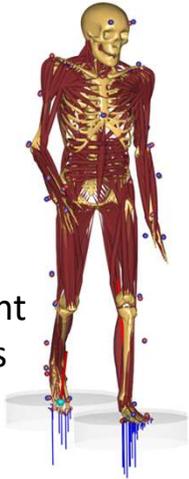
**Motion Data**  
Kinematics and Forces

**Body Loads**

- Joint moments
- Muscle forces
- Joint reaction forces



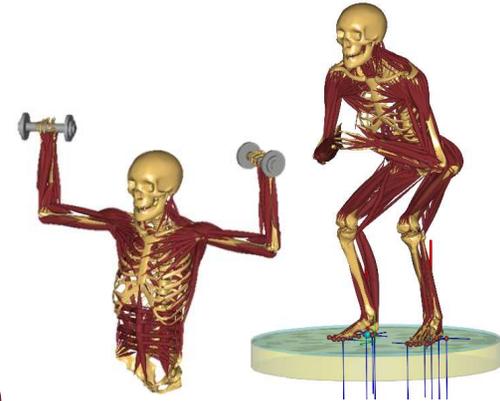
Movement  
Analysis



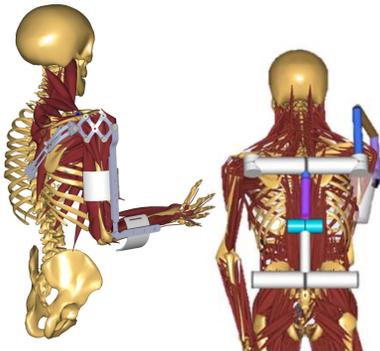
Product optimization design



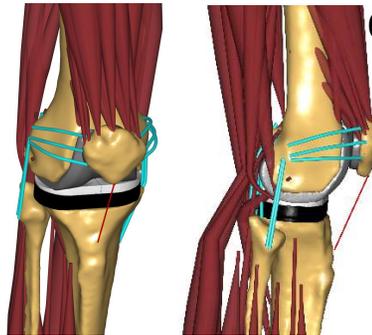
Sports



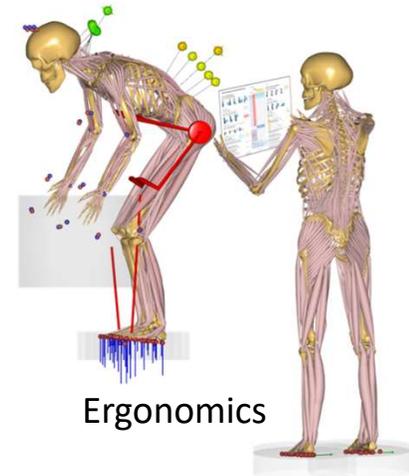
Assistive  
Devices



Orthopedics  
and rehab

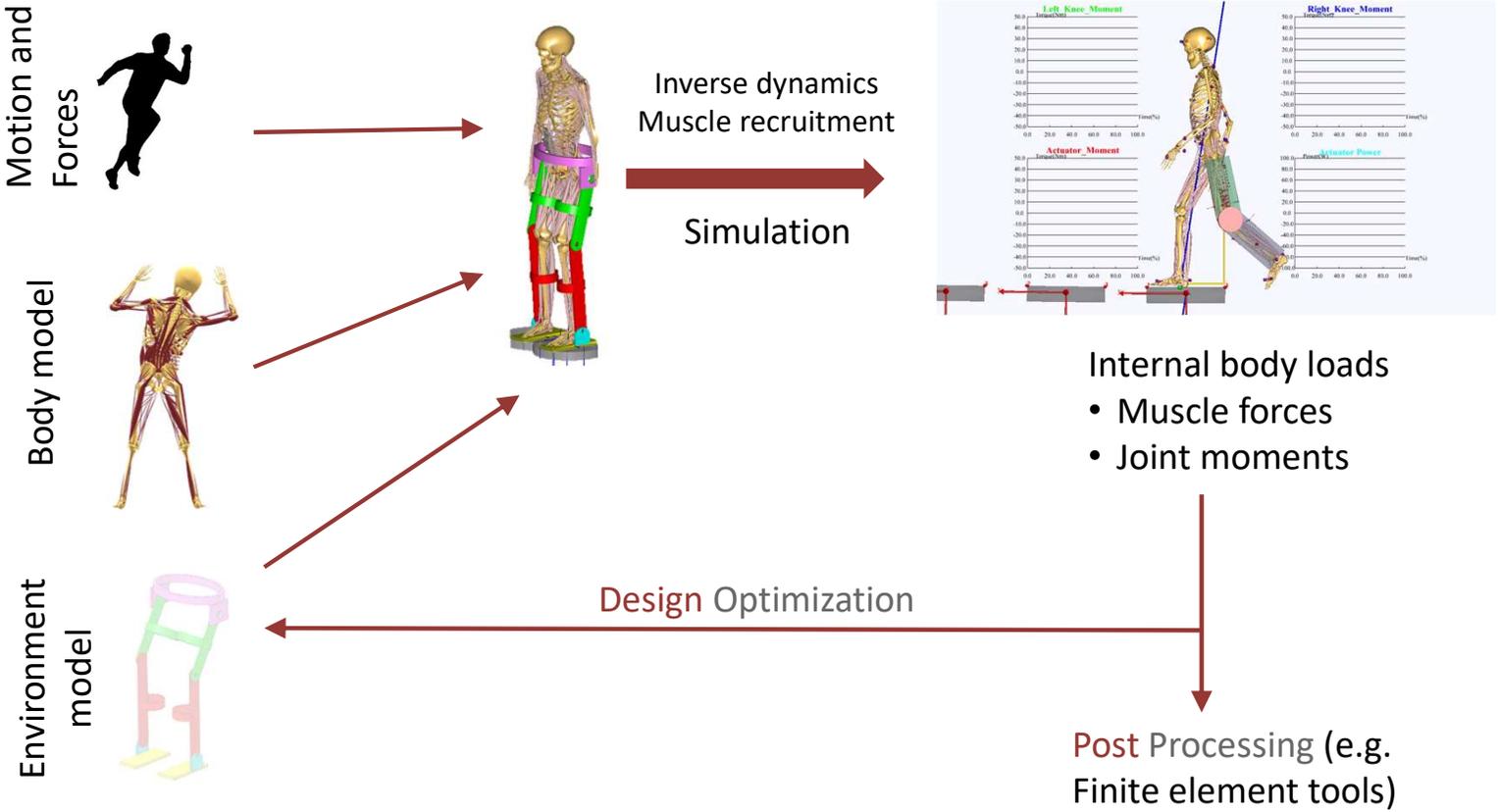


Ergonomics



**ANYBODY**  
Modeling System

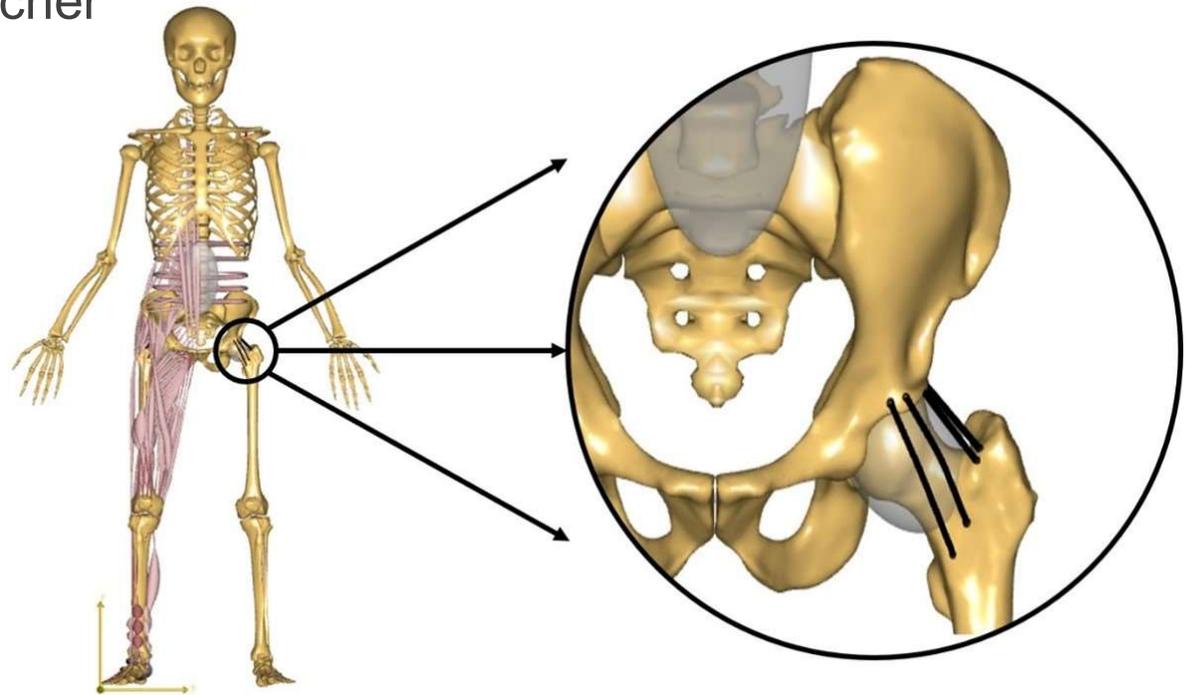
# AnyBody Modelling System

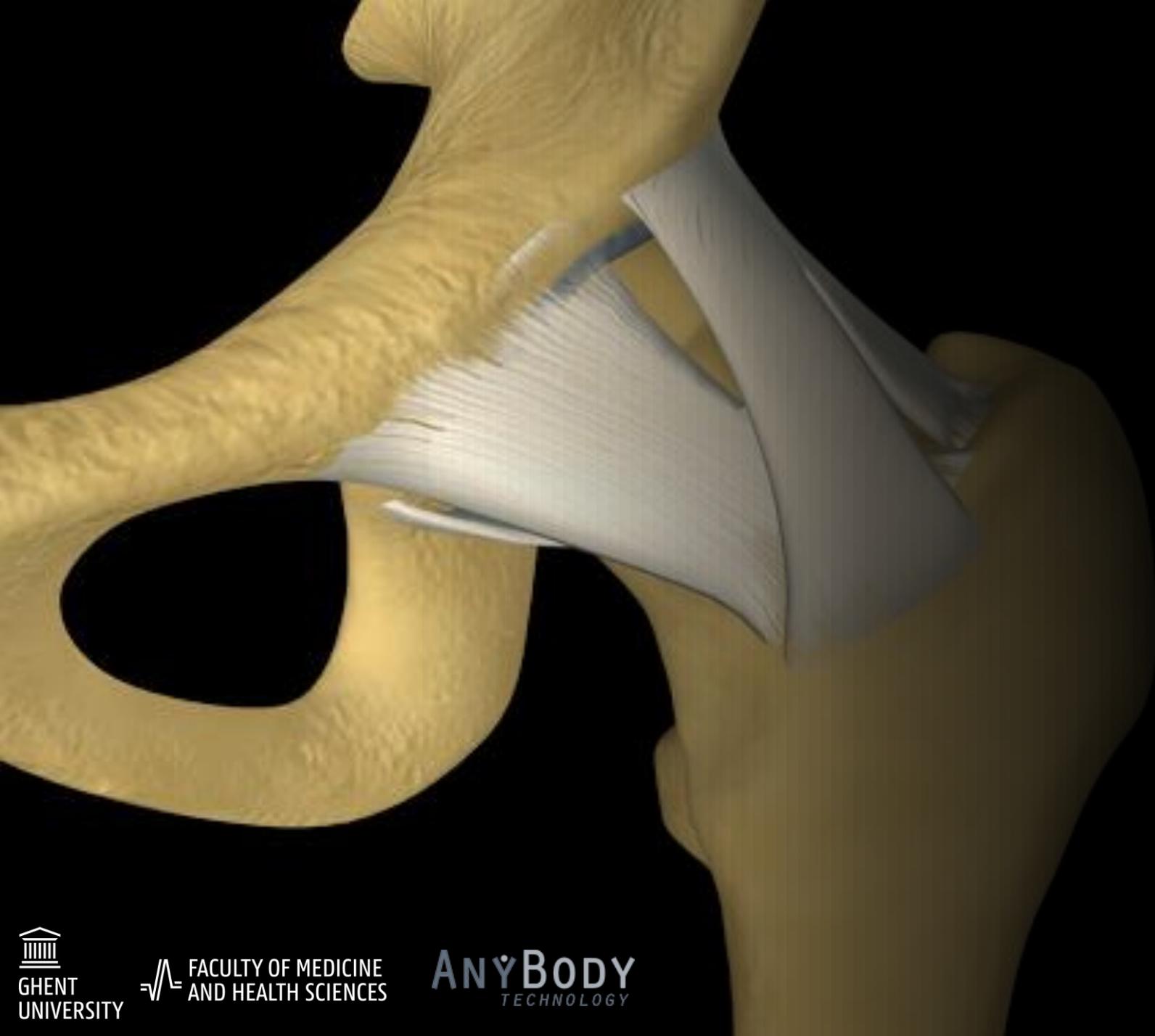


# Simulation-Driven Conceptual Design of Exoskeletons

Presented by Doctoral Researcher

Kate Duquesne





# The Role Of The Anterior Hip Capsule In Daily Hip Performance

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**Kate Duquesne**

Christophe Pattyn

Barbara Vanderstraeten

Emmanuel Audenaert



- 1** Introduction
- 2** Aim
- 3** Methods
- 4** AnyBody implementation
- 5** Relevance



**1** Introduction

**2** Aim

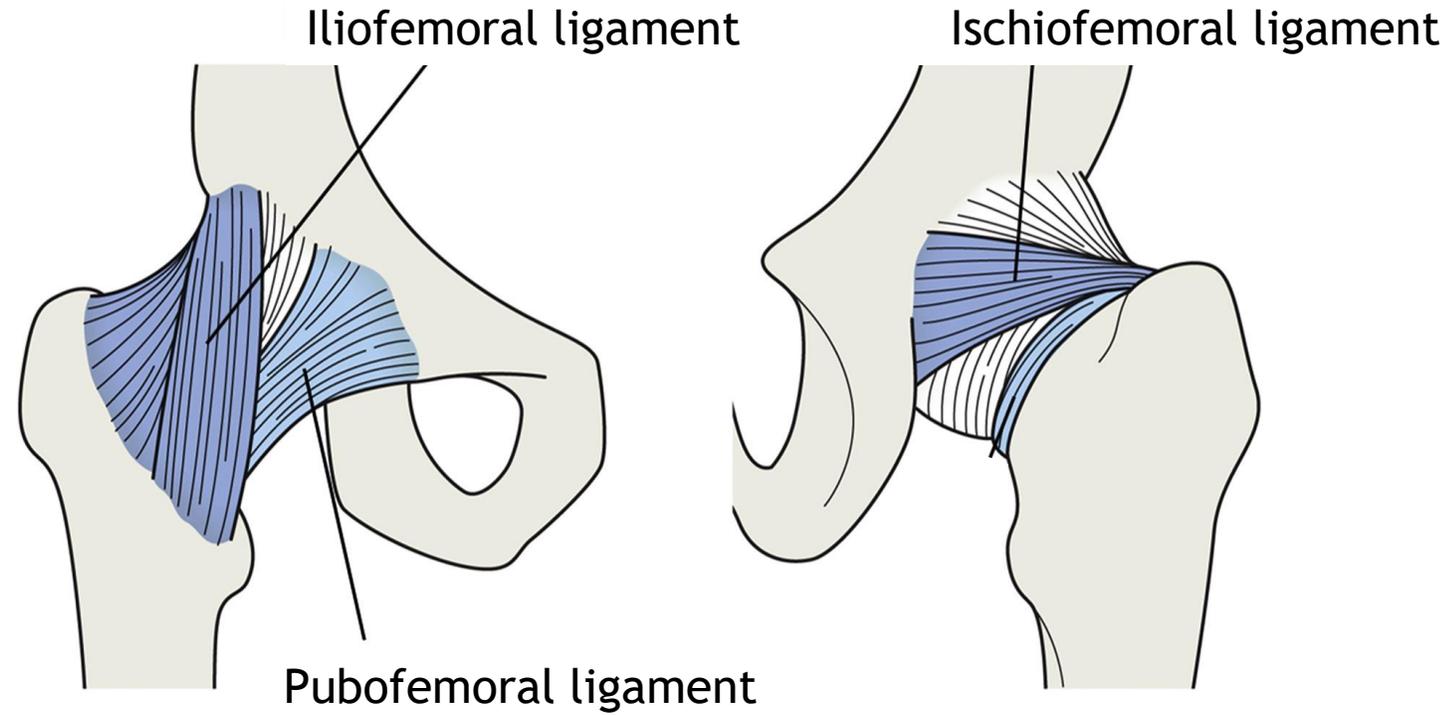
**3** Methods

**4** AnyBody implementation

**5** Relevance

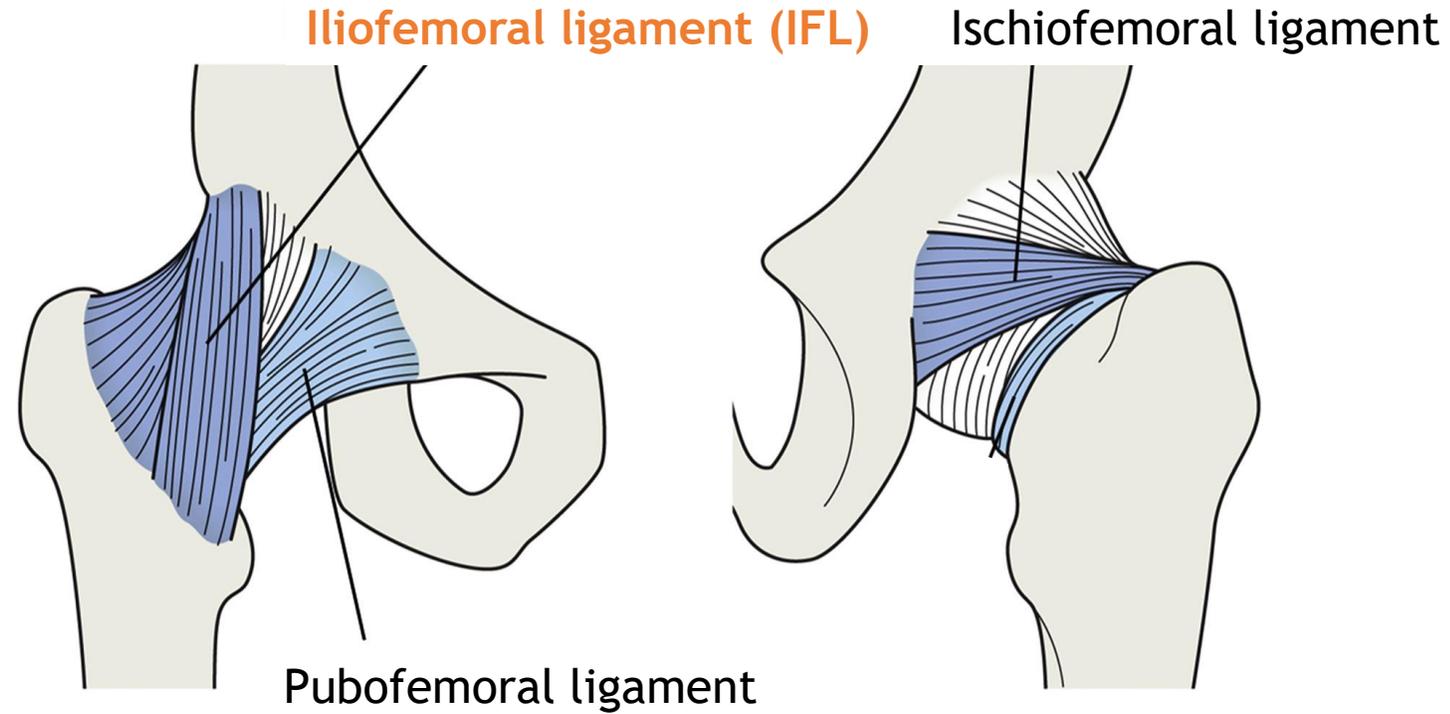
# Introduction

## Hip capsule anatomy



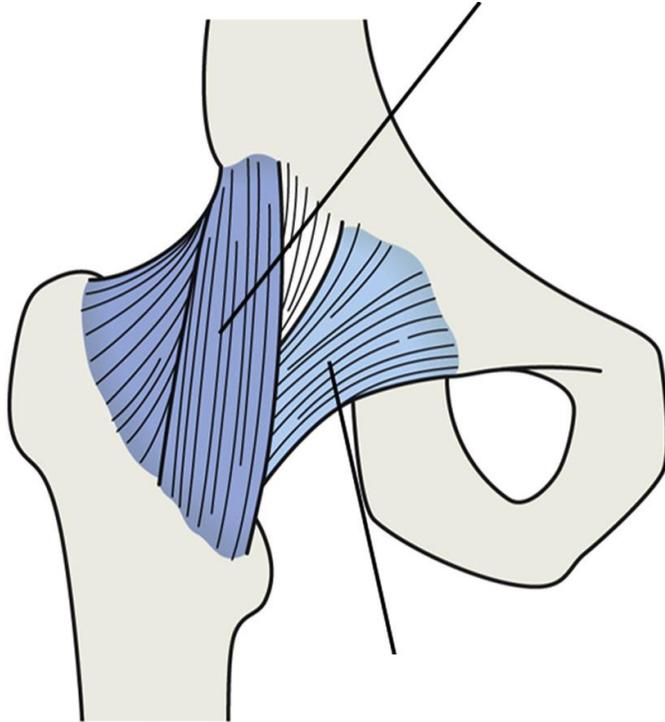
# Introduction

## Hip capsule anatomy



# Introduction

Iliofemoral ligament (IFL)



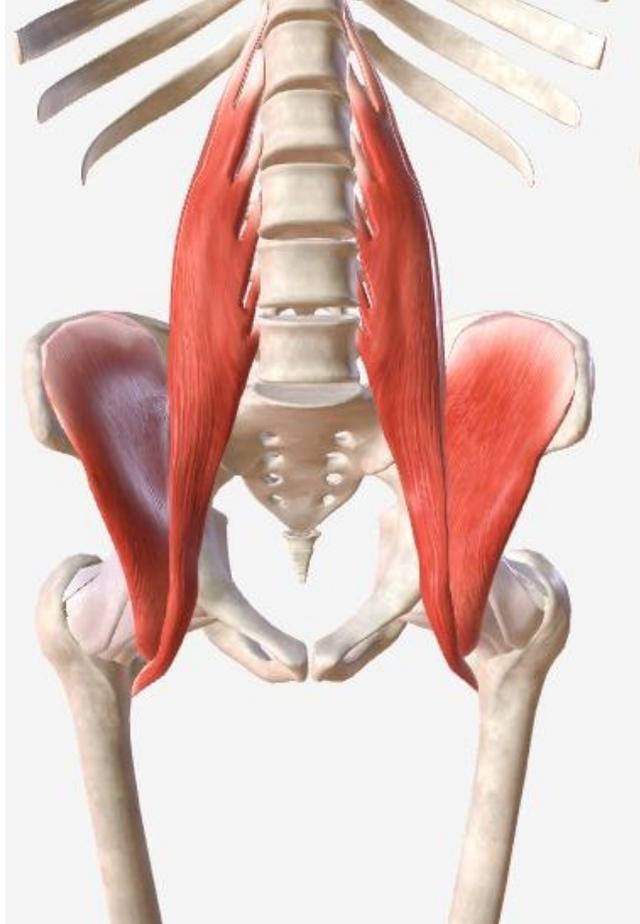
## Iliofemoral ligament

Y-Shaped

Strongest ligament in our body

Passive, joint-stabilizing properties

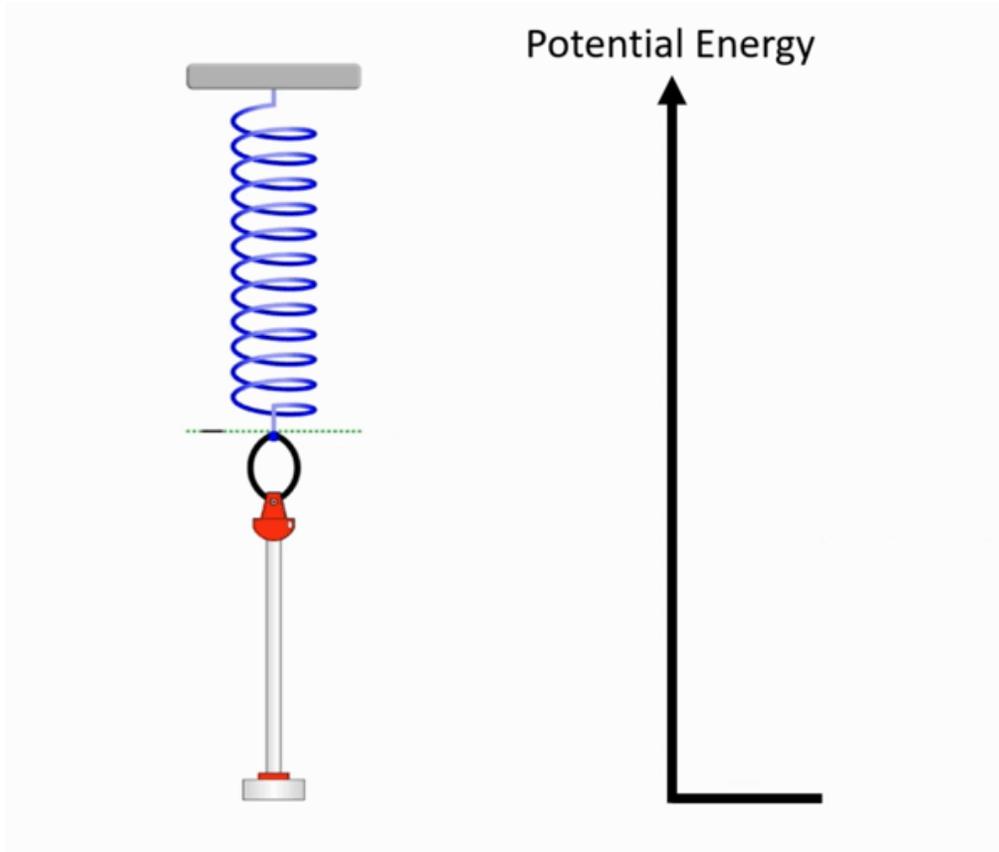
# Introduction



## Iliofemoral ligament

Shares its moment arm with iliopsoas

# Introduction

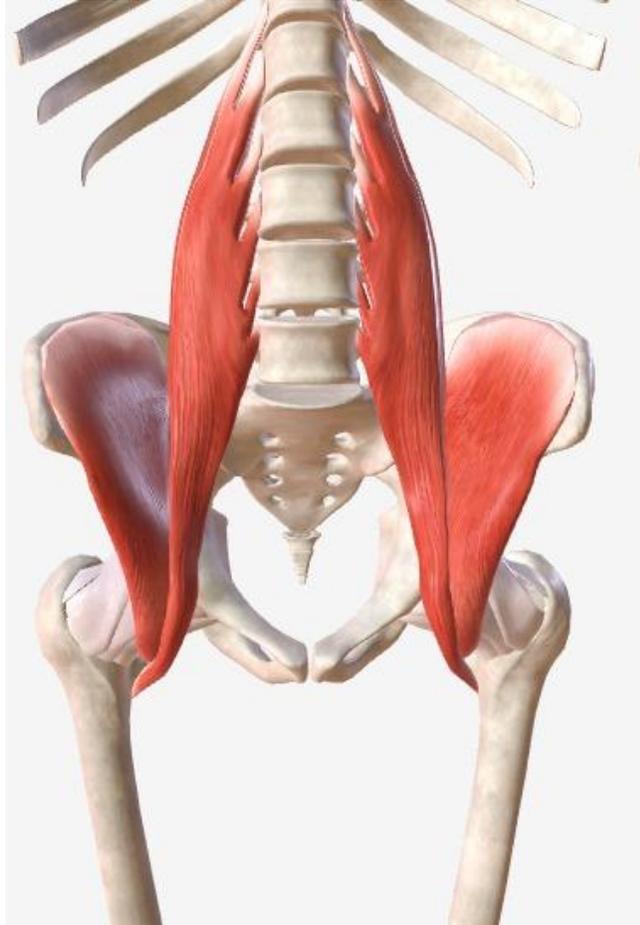


## Iliofemoral ligament

Shares its moment arm with iliopsoas

Ligaments act like springs

# Introduction



## Iliofemoral ligament

Shares its moment arm with iliopsoas

Ligaments act like springs



Reduces the workload of the hip flexors



1 Introduction

2 **Aim**

3 Methods

4 AnyBody implementation

5 Relevance

# Aim



Define the contribution of the iliofemoral ligament to human walking



1 Introduction

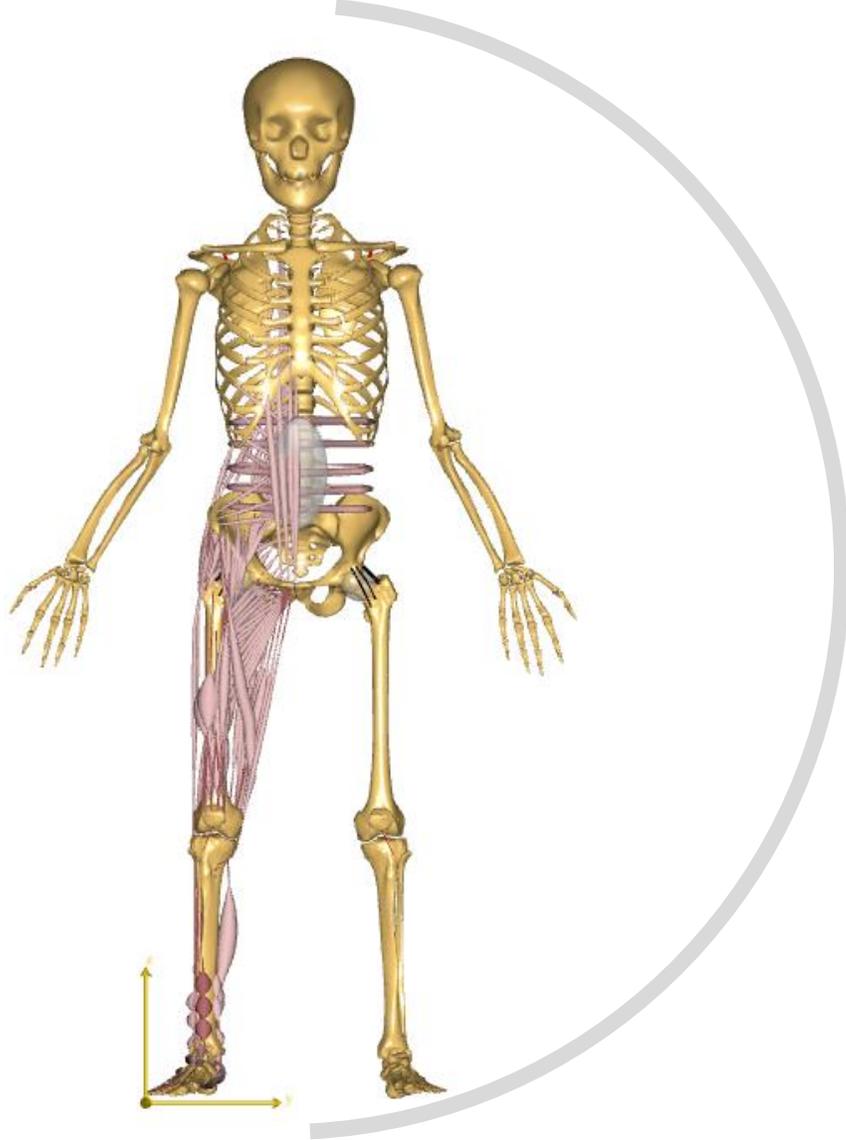
2 Aim

3 **Methods**

4 AnyBody implementation

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# Methods

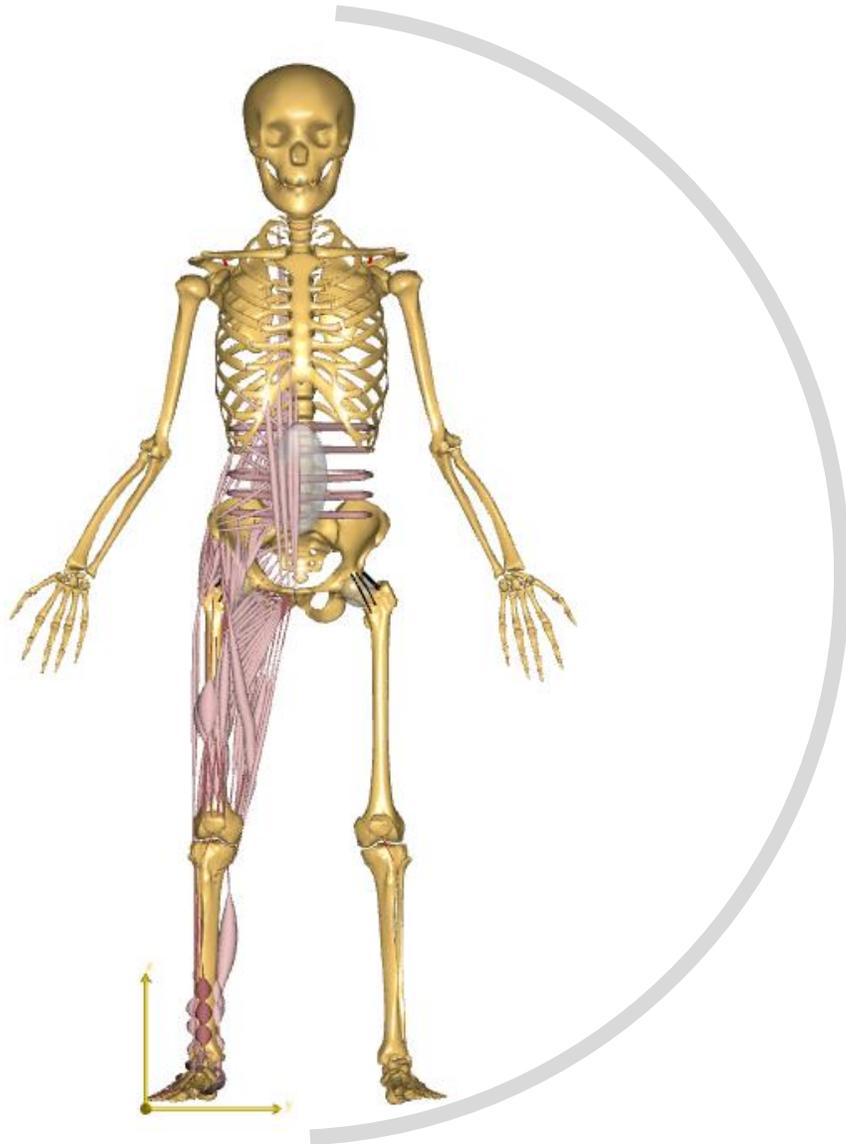


Simulate human gait with and without the IFL



Effect of inclusion of IFL on required work of the hip musculature

# Data set



Schreiber and Moissenet (2019)

Human gait of 50 healthy individuals

19-67 years

1.74 m  $\pm$  0.09 m

71.0 kg  $\pm$  12.3 kg

Straight level

3 trials per subject

Speeds 2.9 - 4.3km/h



1 Introduction

2 Aim

3 Methods

4 **AnyBody implementation**

5 Relevance

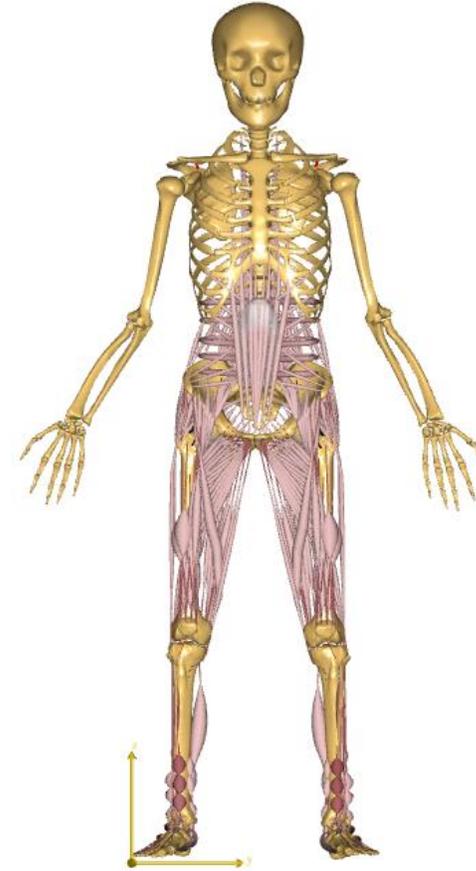
# AnyBody implementation

Bone topology



TLEM 2.1

Muscles



3 Element Hill type  
muscles

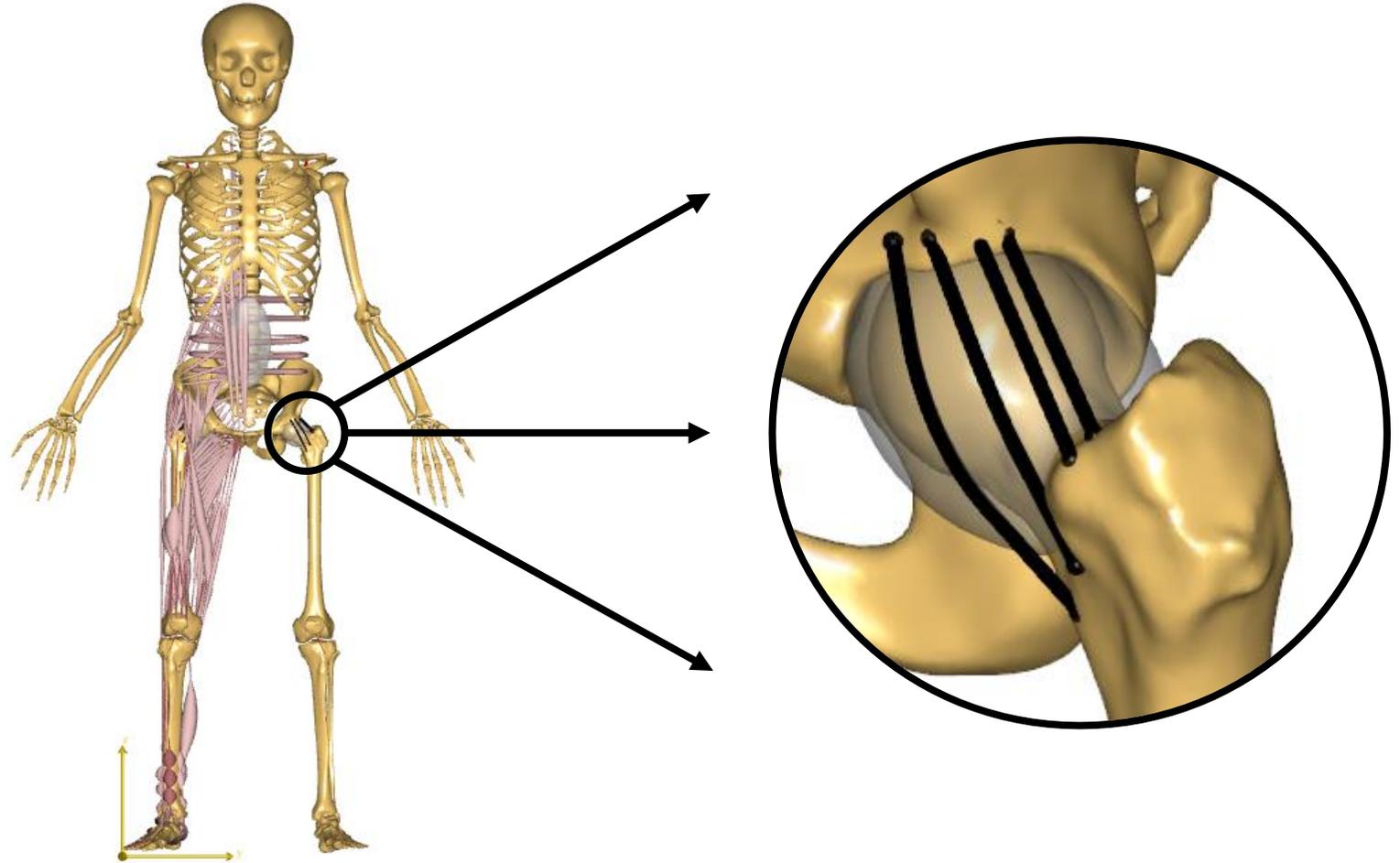
# AnyBody implementation

## Iliofemoral ligament geometry

Superior and inferior part:  
2 springs each

Origins and insertions based on  
Tsutsumi et al. (2020)

Ellipsoid wrapping surface



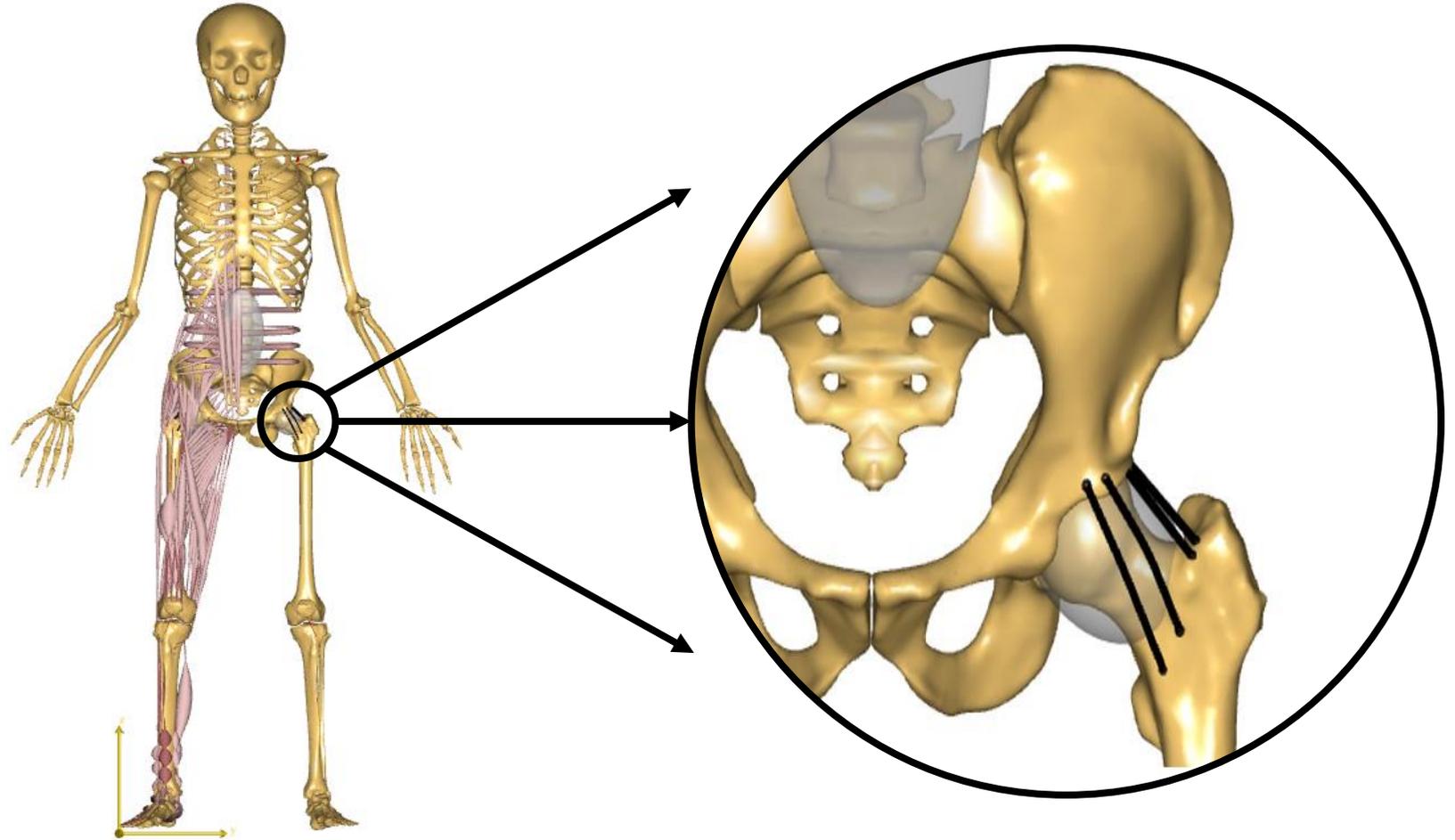
# AnyBody implementation

## Iliofemoral ligament properties

Linear force-displacement relationship

Strength based on Hewitt et al. (2002)

Scaled properties with strength scaling of the pelvic muscles



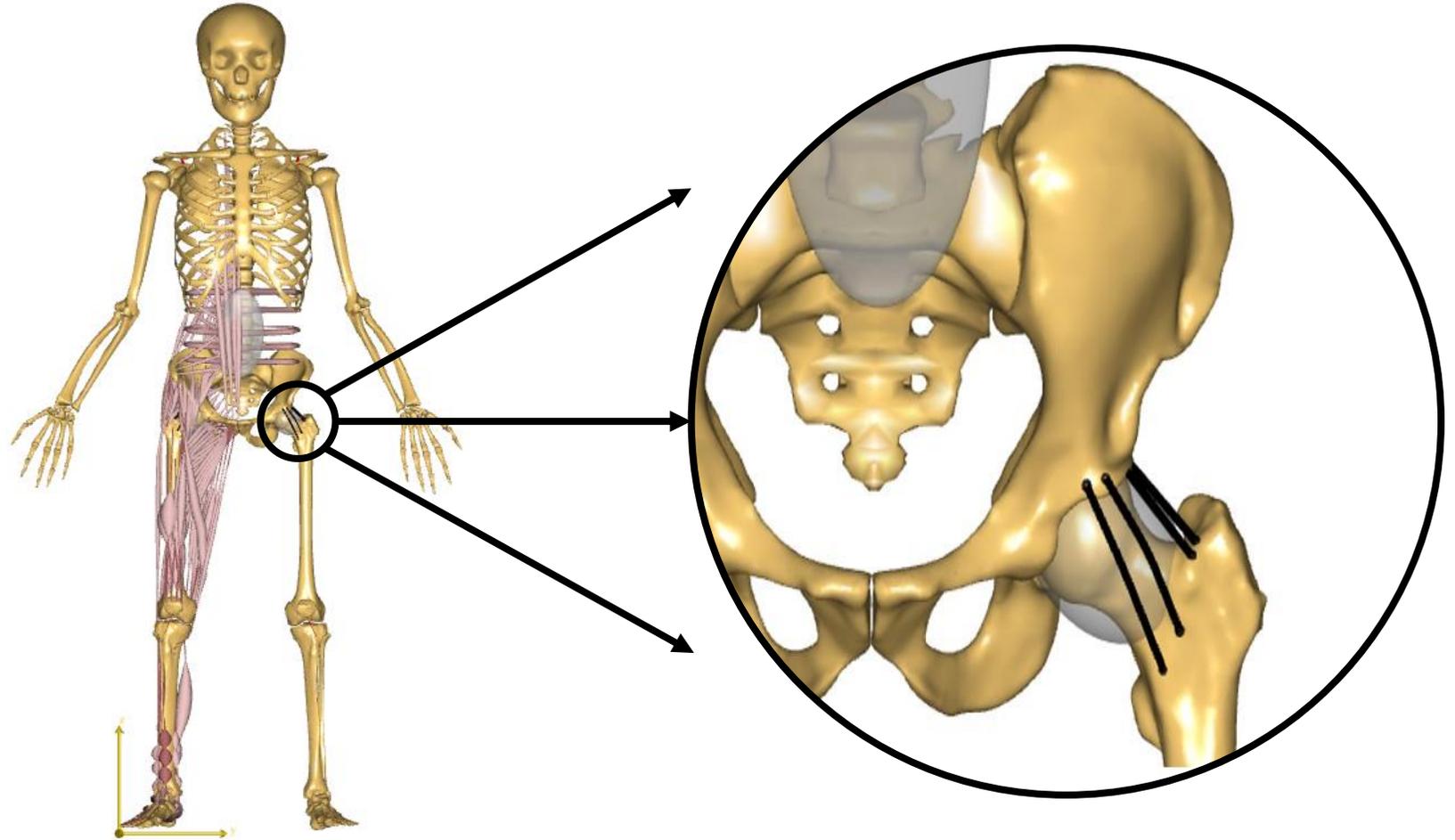
# AnyBody implementation

## Iliofemoral ligament properties

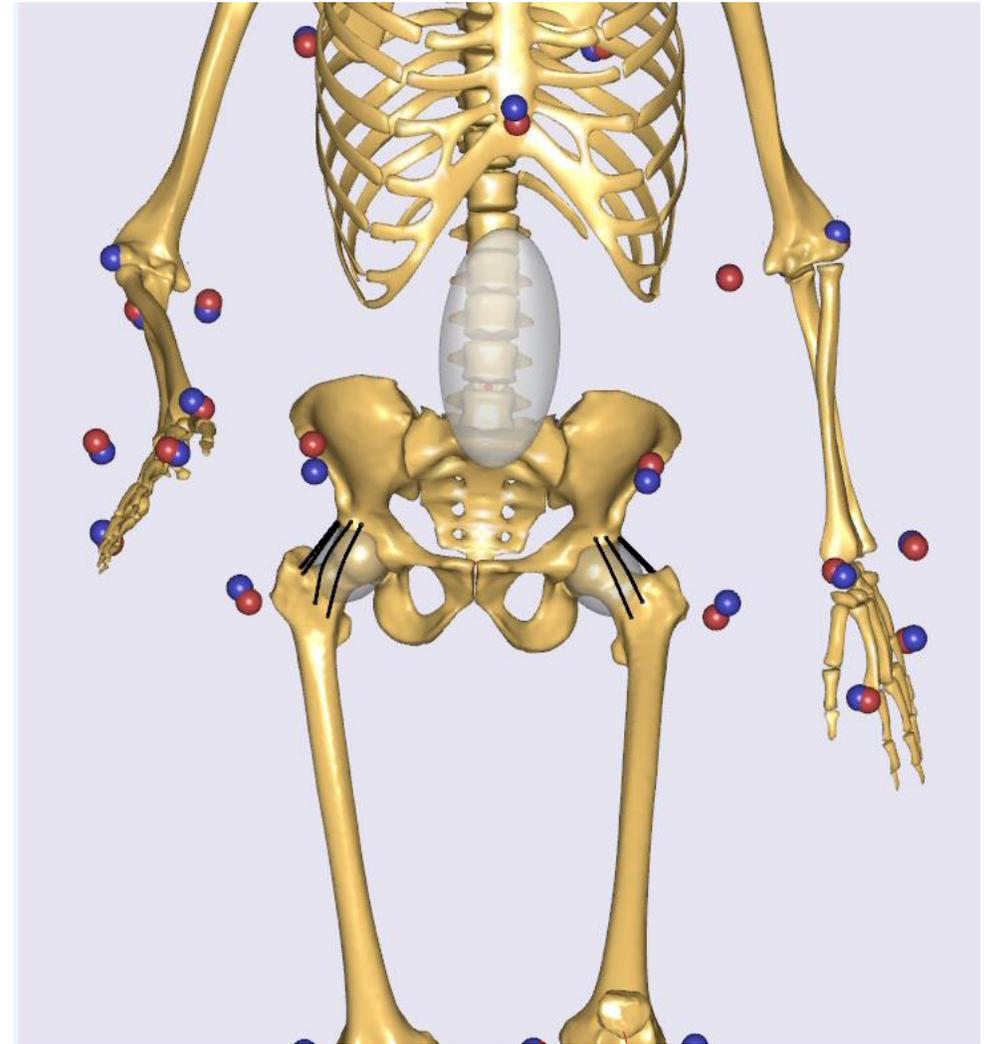
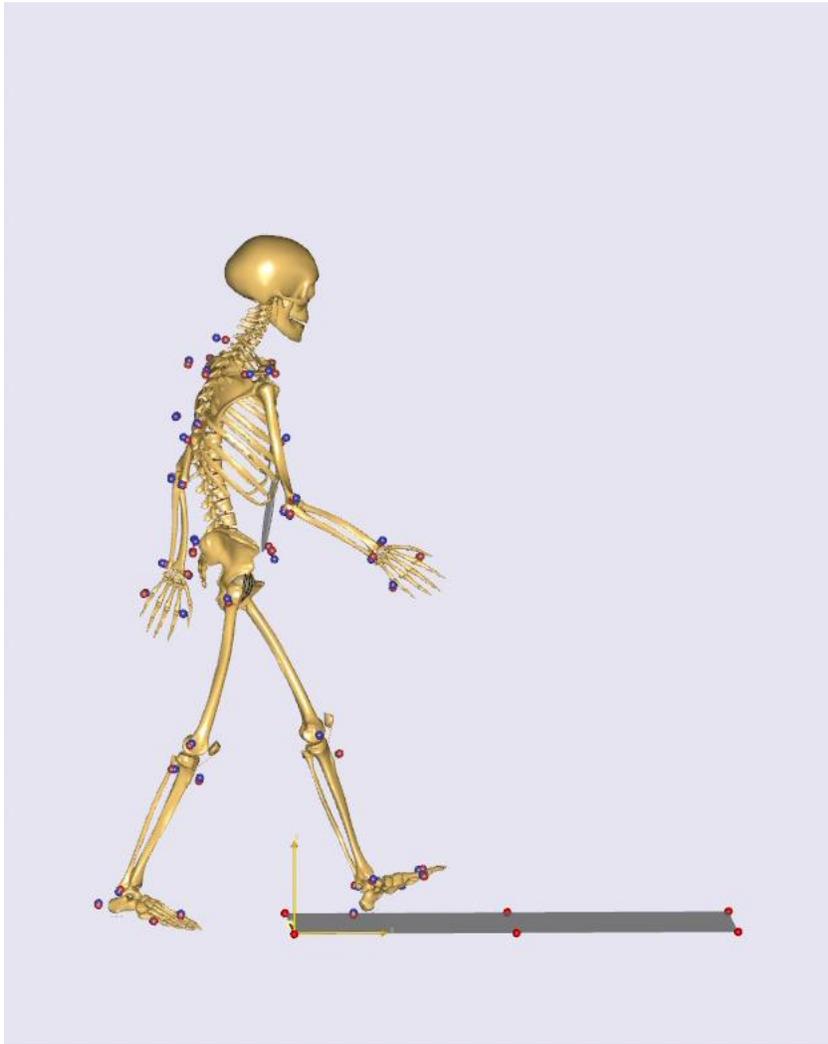
Calibration of the ligament rest length in the neutral standing position of the static trial

Parameter study

25%, 50%, 75% of mean strength found by Hewitt et al. (2002)



# AnyBody implementation



# AnyBody implementation



## Output

Mechanical work performed by the hip muscles

# AnyBody implementation

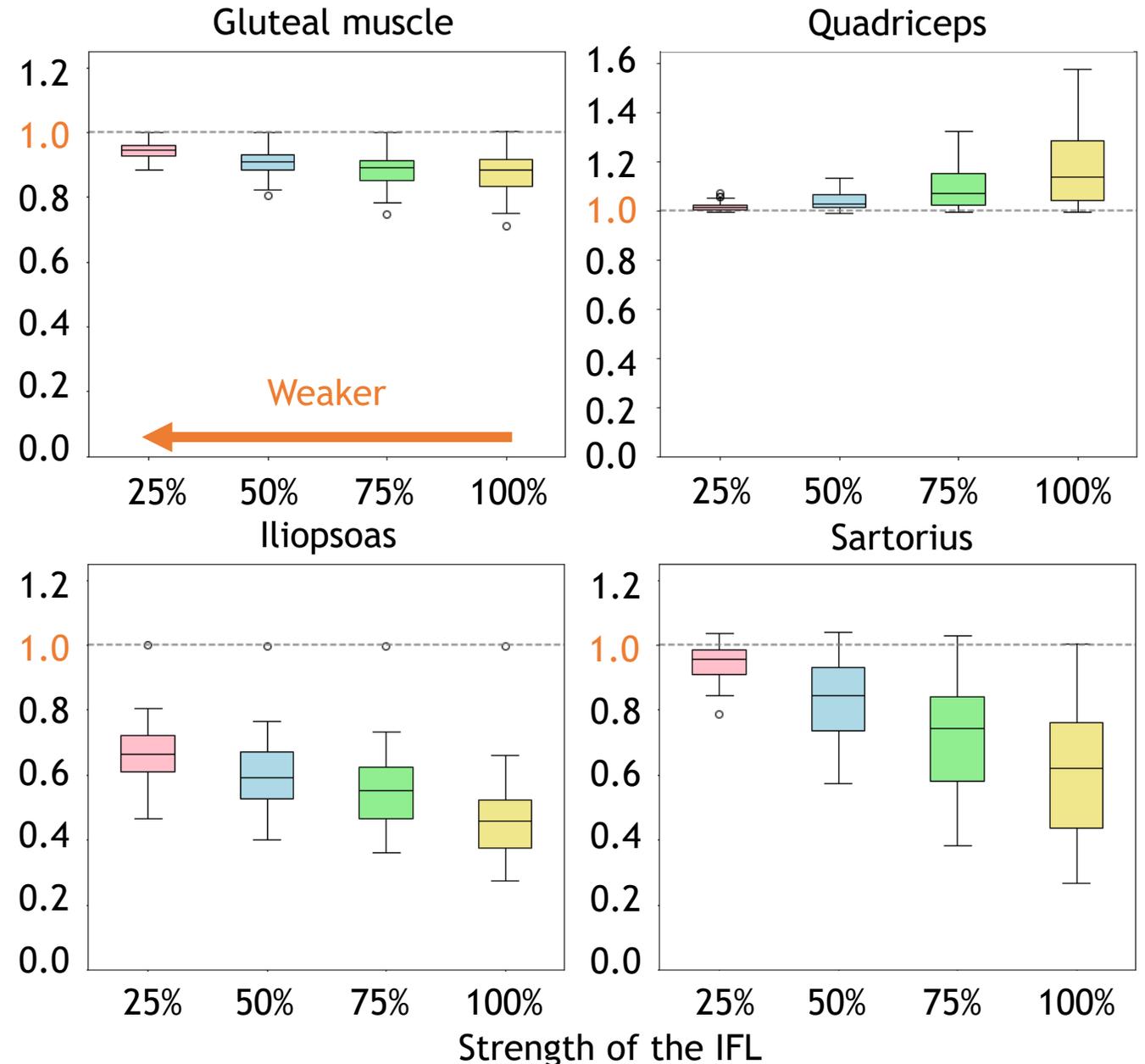
## Results

$$R = \frac{\text{work with IFL}}{\text{work without IFL}}$$

> 1  
 ⇒ more work when IFL is included

< 1  
 ⇒ less work when IFL is included

⇒ Workload for the iliopsoas is significantly reduced





- 1 Introduction
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# Clinical relevance



## Hip arthroscopy

No consensus on capsular management

Biomechanical evidence

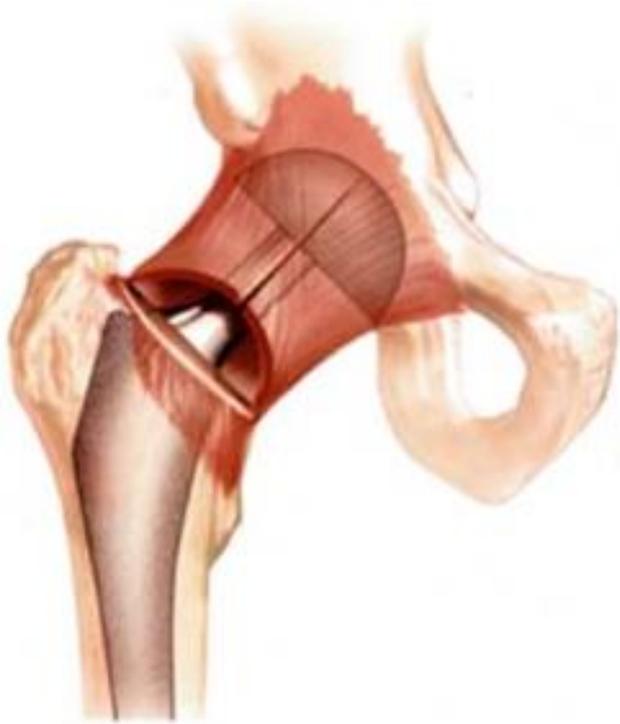
⇒ Maintaining stability

Prospective randomized trial of Economopoulos et al. (2020)

⇒ Better patient reported outcomes when anterior hip capsule is repaired

IFL works synergistically with the hip musculature

# Clinical relevance

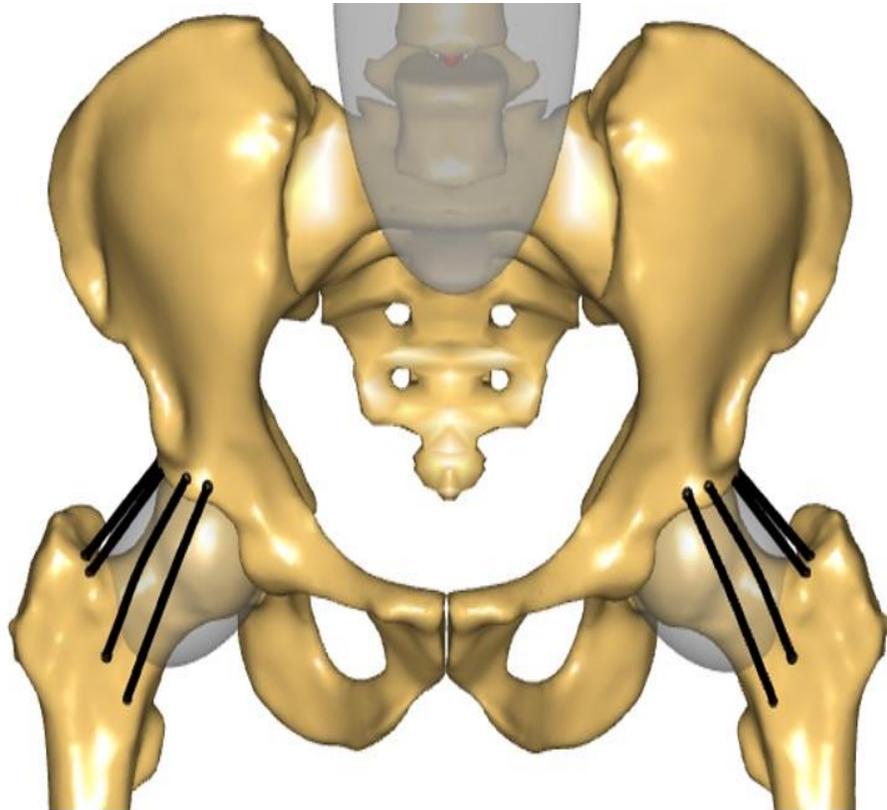


## Hip arthroplasty

No consensus on capsular management and conflicting reports in literature

From a mechanical standpoint, repair seems most appropriate

# Implications for research

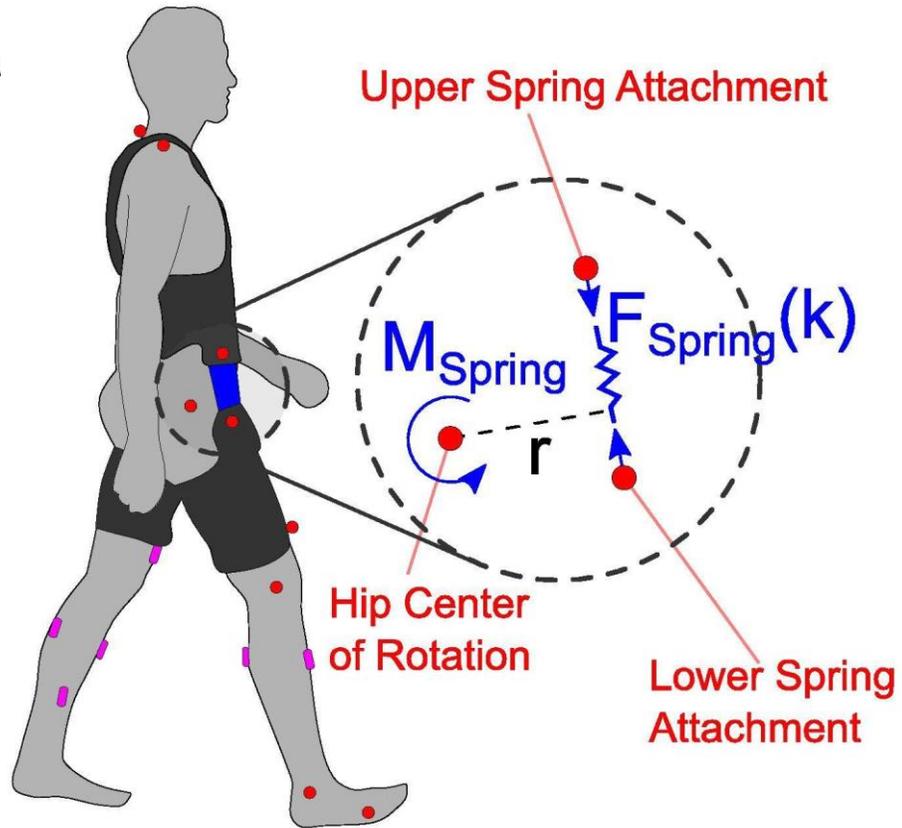


## Inclusion in musculoskeletal simulations

Interested in hip flexors for motions with hip extension

Recommend including the anterior hip capsular ligaments

# Implications for research

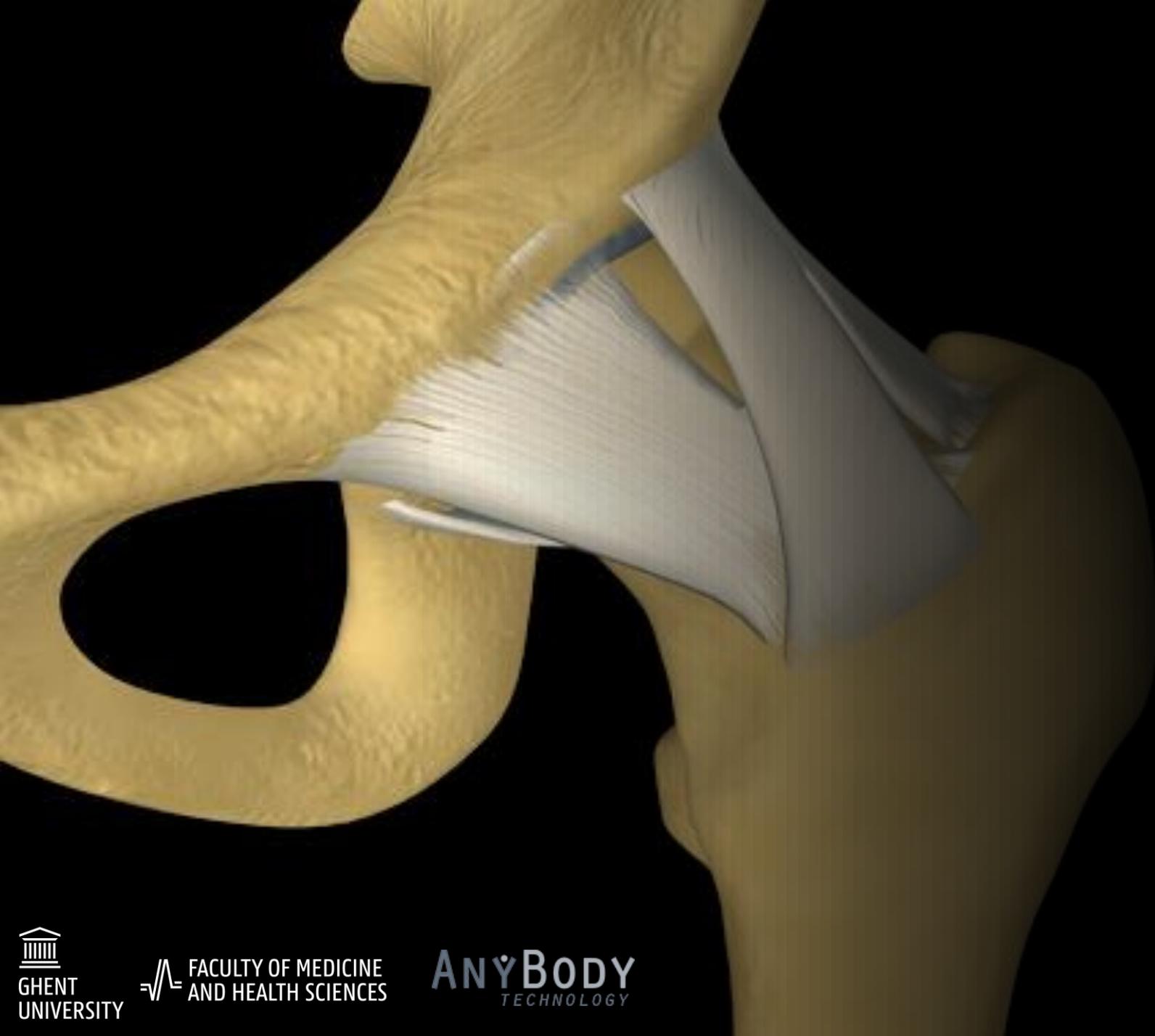


## Exoskeletons

Passive spring-like structures can store and return energy during cyclic movements

Reduce the energetic cost of locomotion

Haufe et al. (2020) illustrated that participants' contribution to hip power reduced with 23%



# The Role Of The Anterior Hip Capsule In Daily Hip Performance

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Thank you for your attention  
- Time for questions

