

# Comparison of hip joint muscle forces before and after total hip replacement

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## Motivation

- Numerical multibody simulations based on instrumented gait analysis enable the estimation of muscle forces
- This holds great potential for improved analysis of pathological gait patterns and assessment of treatment success
- Clinical application is limited still by the dependency of the results on model assumptions

## Objective

of this pilot study: test the plausibility of the the numerical results

- comparison of pre- and post-op hip muscle activation patterns of the affected leg in hip osteoarthritis (OA) patients with THR
- comparison of the pre-op activation pattern of selected muscles to electromyographic (EMG) measurements

## Material & Methods

Study group (1 day pre-op):

| n  | Age in years | Weight in kg | Affected leg     | Sex               |
|----|--------------|--------------|------------------|-------------------|
| 10 | 65.1 ± 9.5   | 78.2 ± 9.0   | 7 right / 3 left | 5 female / 5 male |

### Experimental protocol

3D gait analysis pre- and post-op (interval: 21 ± 4 months):

- 8-camera VICON motion capture system MX 10, 200 Hz
- 2 AMTI force plates, 1000 Hz
- Lower body protocol: Stief et al., J Appl Biomech 29 (2013)
- Level barefoot walking at self selected speed, 15 m long walkway (pre-op: 1.0 ± 0.1 m/s, post-op: 1.2 ± 0.1 m/s)

### EMG measurements

- Recording: 16-channel surface EMG system (myon AG)
- Processing: ProEMG (v1.3.07, Prophysics)

### Musculoskeletal modelling

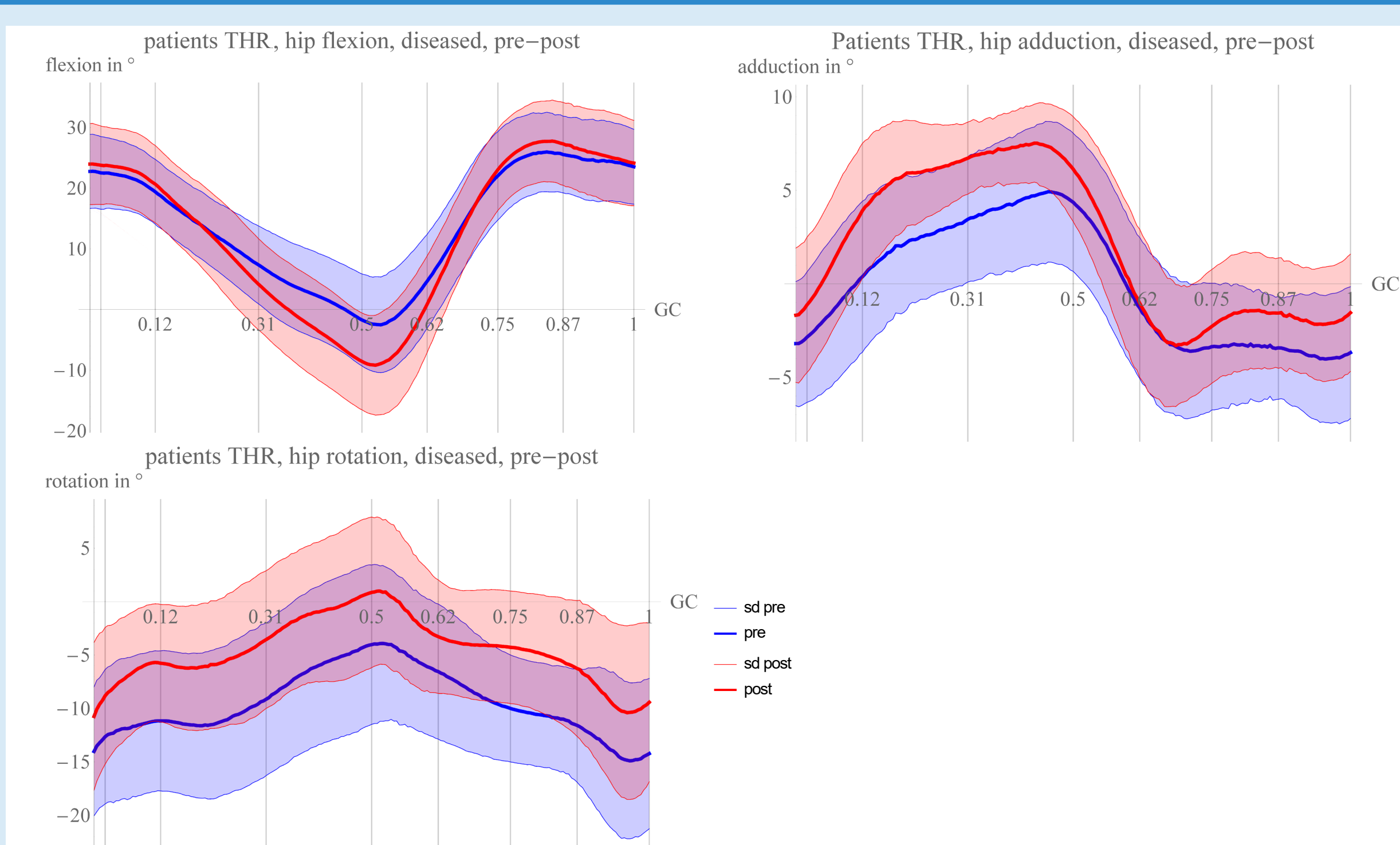
- Pre- and post-op models were scaled separately to fit body weight, mechanical axis angle was aligned patient-specifically
- Full-body model acc. to Lerner et al., J Biomech, 48 (2015)
- Hip kinematics and muscle forces were estimated by numerical musculoskeletal models in OpenSim 3.3 using inverse kinematics and static optimization, respectively, for all patients for pre- and post-op data

### Further data processing (WOLFRAM Mathematica 10)

EMG, kinematics and muscle forces

- time-normalized to 1 gait cycle
- mean values of 3 trials for each patient were used for pre- and post-op, each

## Hip kinematics pre- and post-op

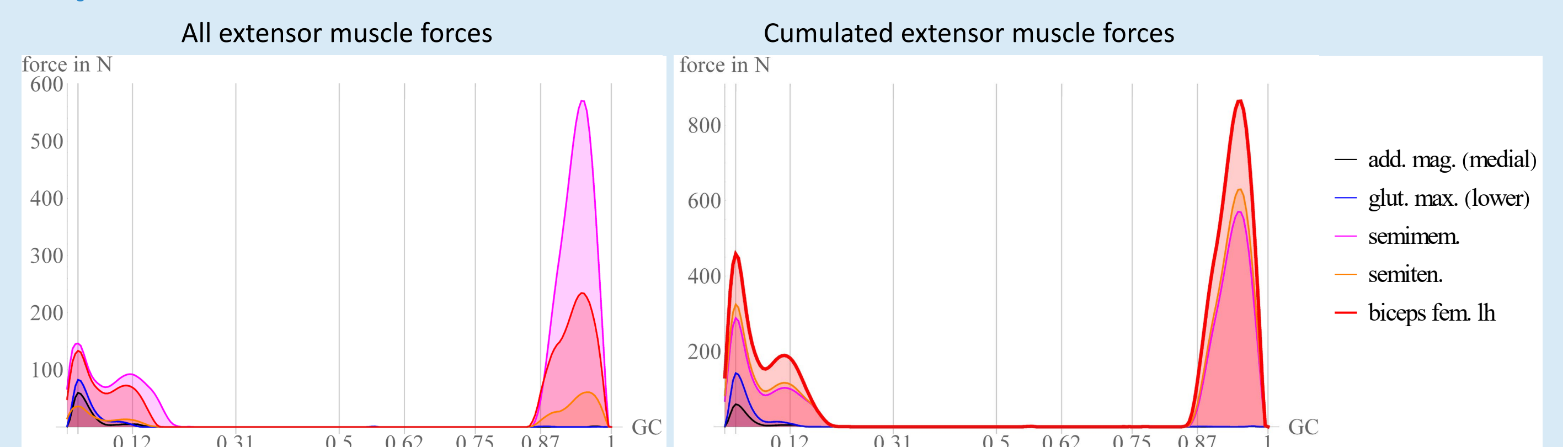


## Hip muscle forces pre- and post-op

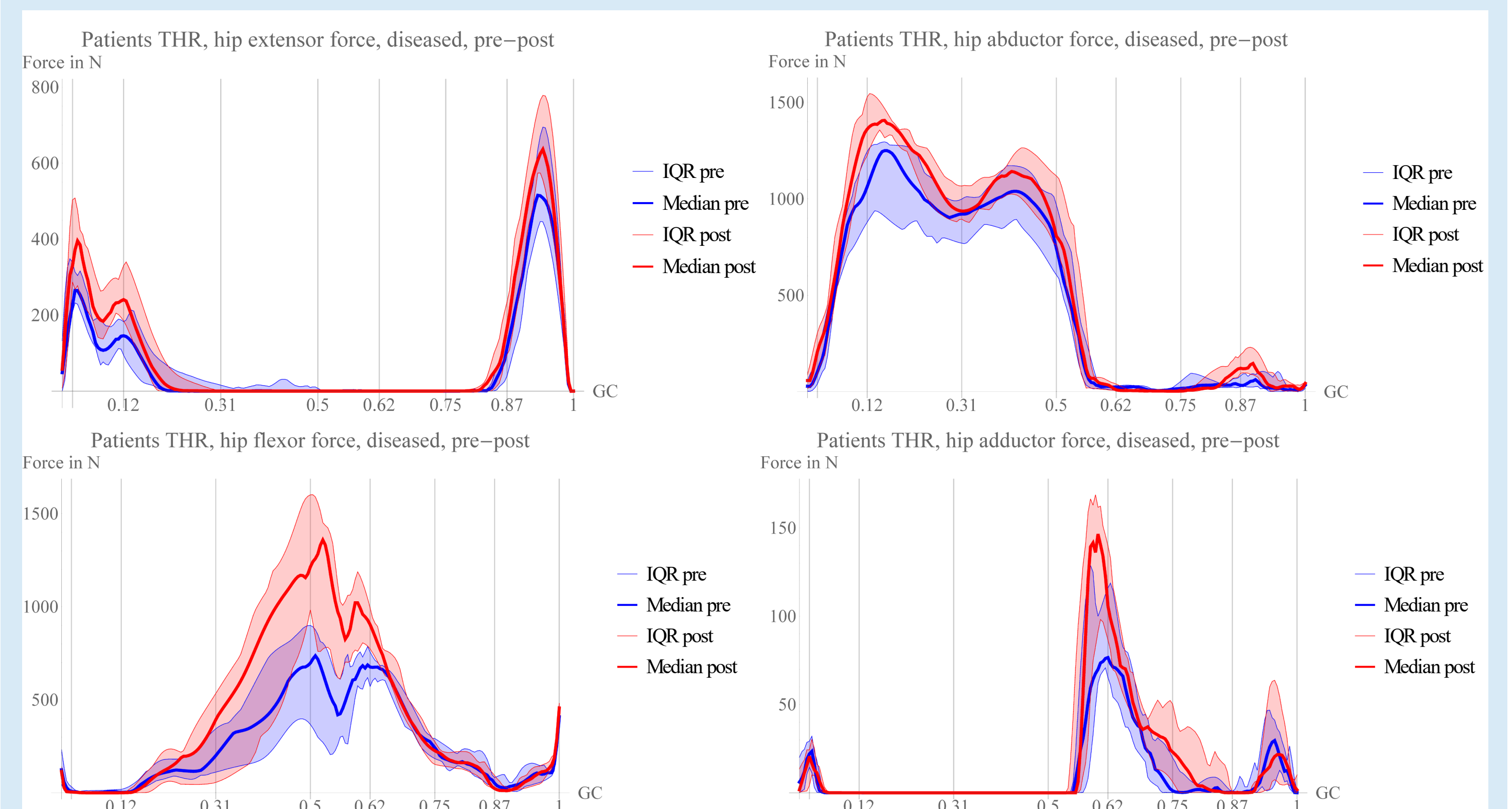
### Evaluated muscle forces (affected hip)

| Extensors             | Flexors    | Abductors          | Adductors         |
|-----------------------|------------|--------------------|-------------------|
| Add. mag. (medial)    | Add. long. | Glut. max. (lower) | Add. long.        |
| Glut. max. (lower)    | Rect. fem. | Glut. med.         | Add. mag. (upper) |
| Semimembranosus       | Gracilis   | Tensor fasc. lat.  | Gracilis          |
| Semitendinosus        | Sartorius  |                    |                   |
| Biceps femoris, l. h. | Iliacus    |                    |                   |
|                       | Psoas      |                    |                   |

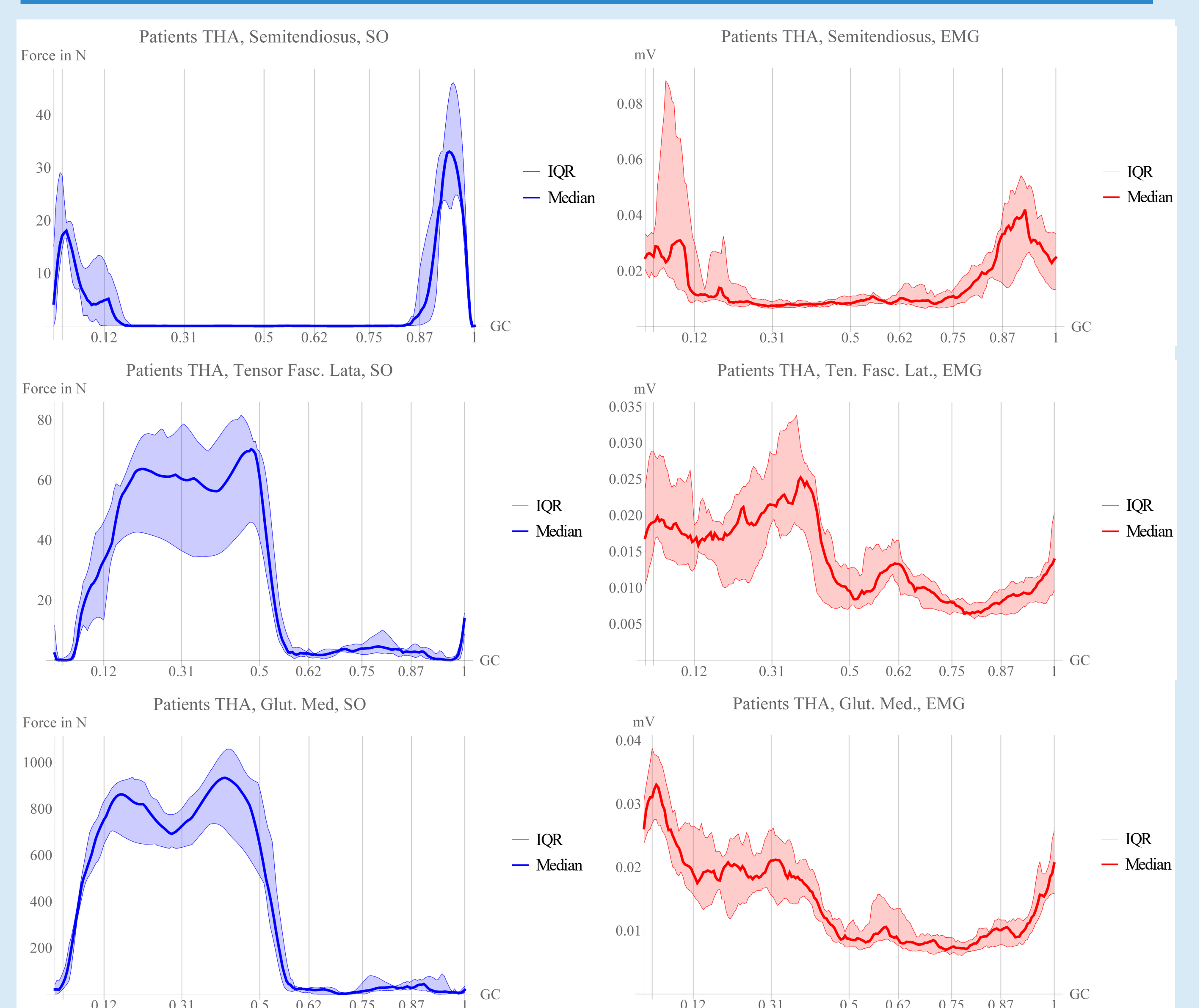
### Representation of cumulated muscle forces



### Comparison of cumulated forces pre- vs. post-op



## Comparison with EMG data



## Acknowledgement

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