

# 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
- Clinical application is still limited by the dependency of the results on model assumptions

## Objective

Test the plausibility of the the numerical results

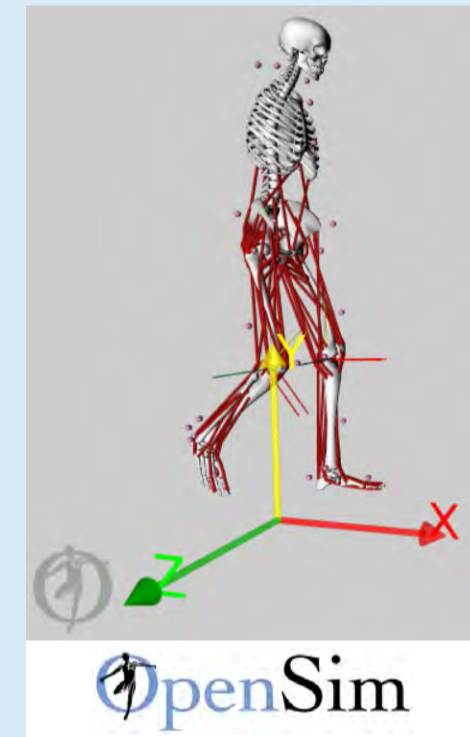
- comparison of hip muscle force patterns of the affected leg in hip osteoarthritis patients with THR: pre-operative ↔ post-operative
- correlation: force pattern of selected muscles ↔ EMG measurements (pre-operative data)

## 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

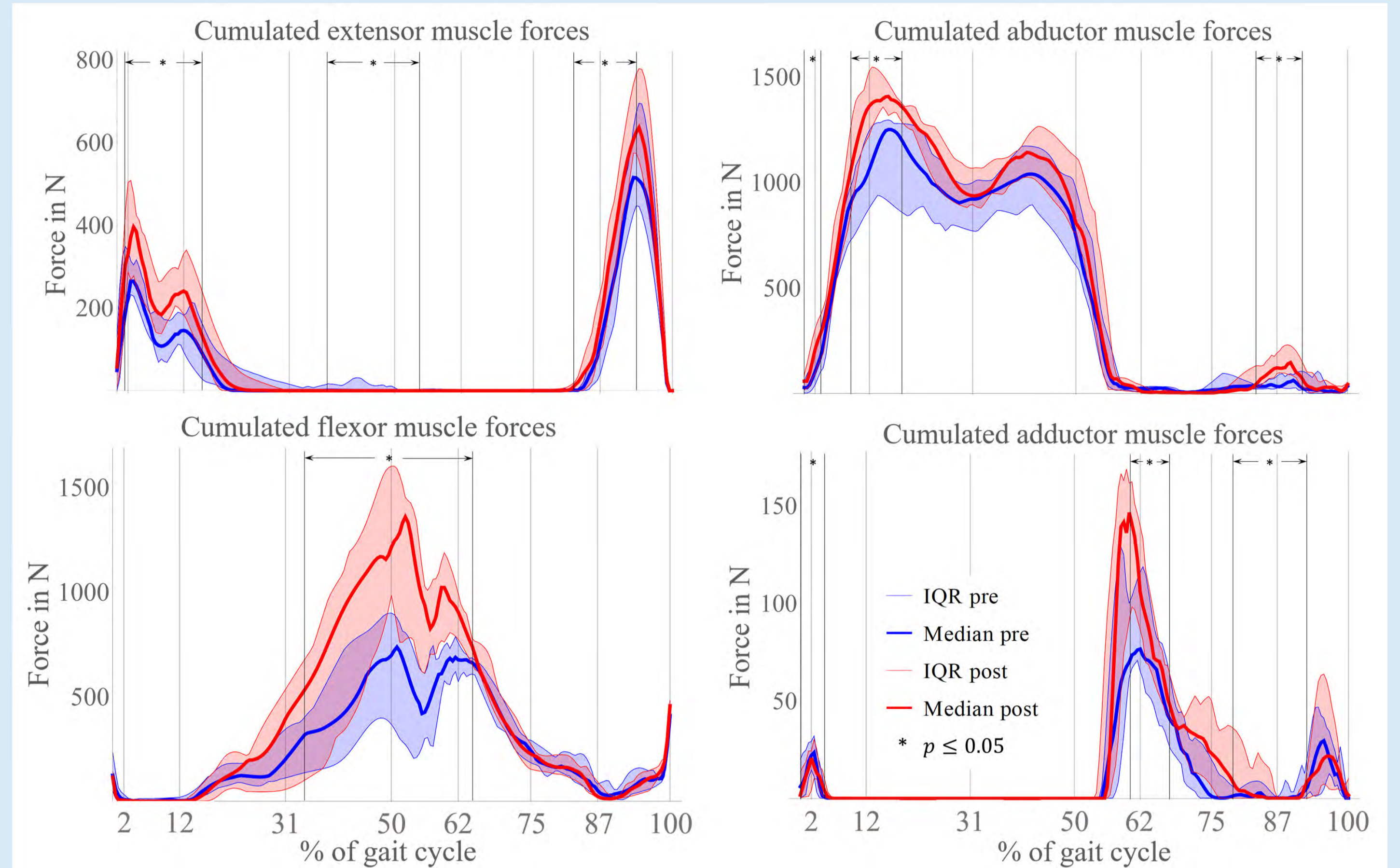
- 3D gait analysis pre- and post-op (interval: 21 ± 4 months) [1]
- Surface EMG measurements:  
Semitendinosus – Tensor Fasciae Latae – Gluteus Medius
- Full body musculoskeletal model of Lerner [3] (OpenSim 3.3)
- Hip kinematics and muscle forces (static optimization) pre- and post-operatively
- Postprocessing on mean values of 3 trials for each patient
- For pre/post comparison, cumulated muscle forces of functional groups were evaluated



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		

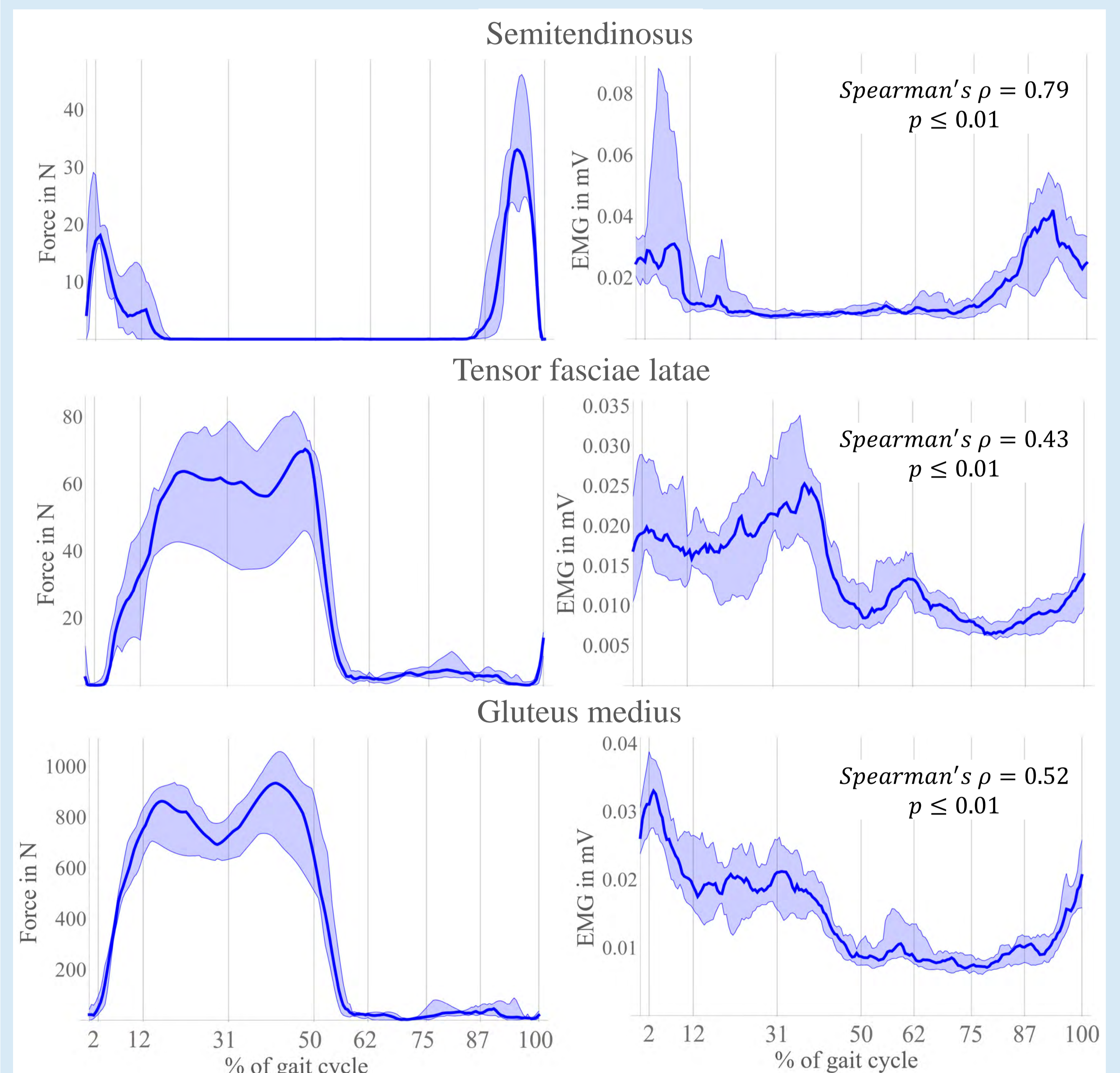
## Comparison of grouped muscle force pre- and post-op

Wilcoxon Signed Rank Test (non-parametric test, Wolfram Mathematica 10)



## Correlation of selected muscle forces with EMG measurements

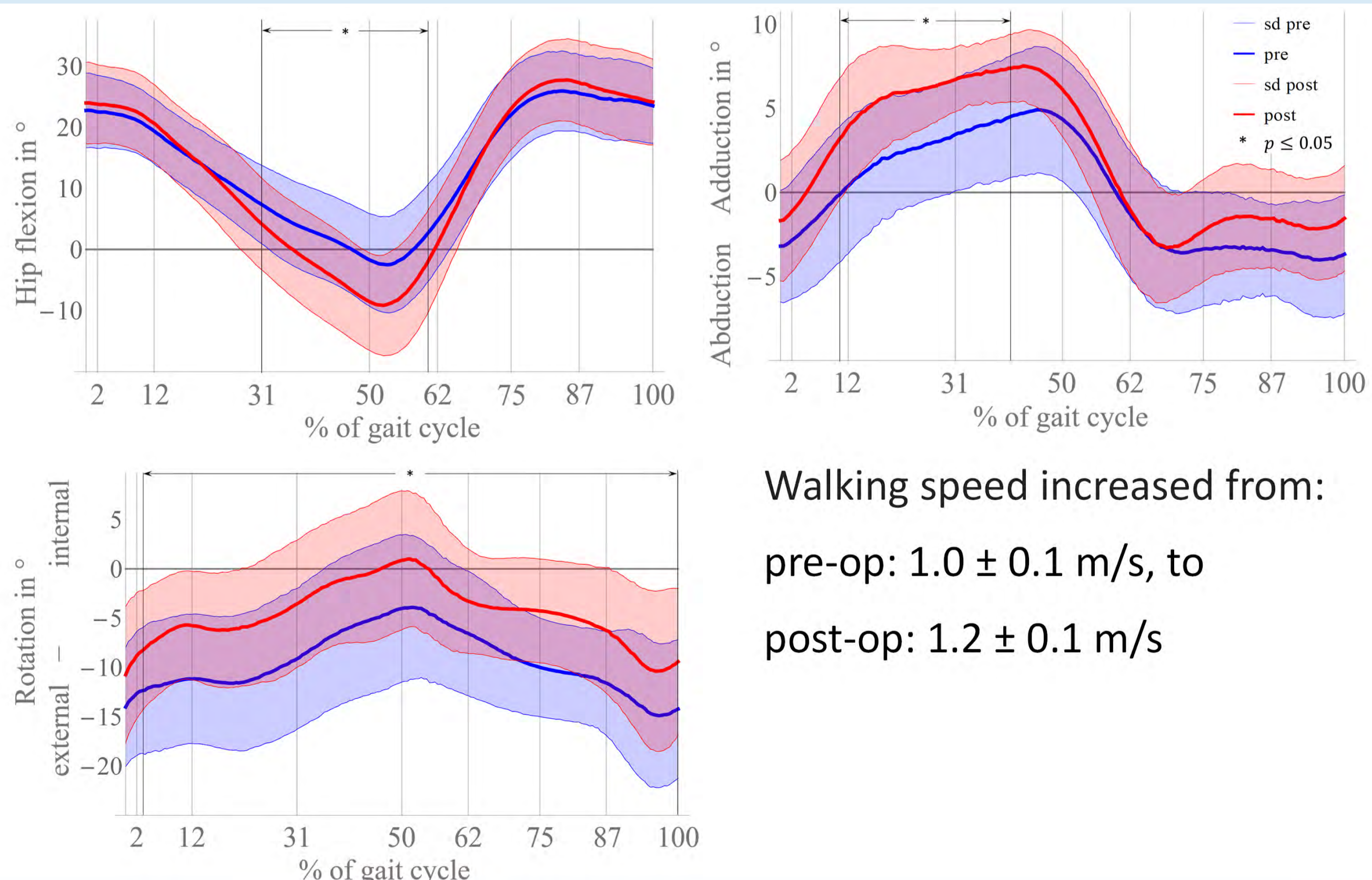
Spearman's Rank Correlation  $\rho$  (non-parametric correlation, Wolfram Mathematica 10)



## Results

### Hip kinematics pre- and post-op

Paired t-Test (Wolfram Mathematica 10)

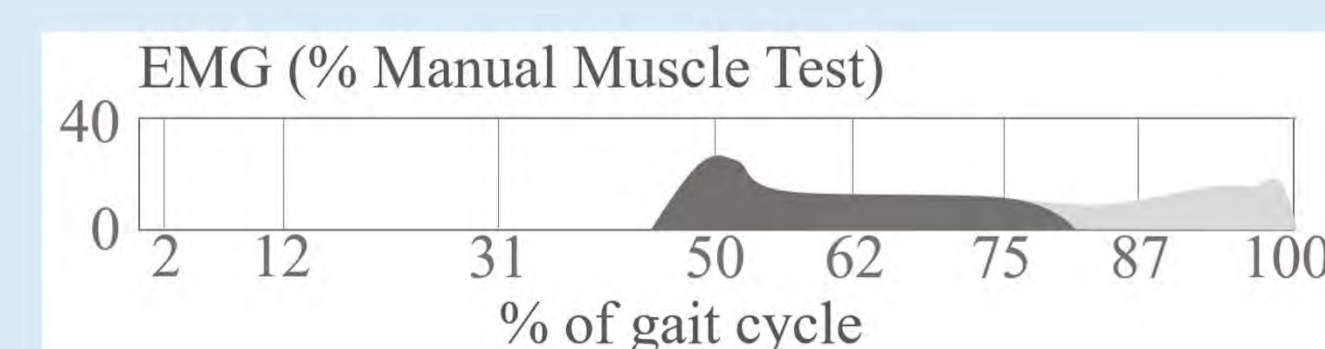


Walking speed increased from:  
pre-op: 1.0 ± 0.1 m/s, to  
post-op: 1.2 ± 0.1 m/s

## Discussion and conclusion

The estimation of muscle forces by use of numerical models provides plausible results in most cases:

- postoperatively greater muscle forces ↔ increase in walking speed
- comparison of muscle force activation patterns ↔ EMG measurements.
- non-physiological activation peak of the flexor muscles in terminal stance → iliofemoral ligament forces missing in the model must be compensated



Activity period of hip flexor muscles after Perry, Burnfield 2010 [4]

## Acknowledgement

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## References

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- Stief et al. (2013) J. Appl. Biomech.
- Lerner et al. (2015) J. Biomech.
- Perry & Burnfield, Gait analysis, 2010