Developing and Validating an ArtiSynth Multibody Model for Gait Analysis

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Introduction

- Studying effects of gait impairments on tissue level requires coupling multibody (MB) and finite element (FE) simulation analyses.
- Using existing multibody models as foundation in new frameworks for coupled simulations (like ArtiSynth) can facilitate research.
- ArtiSynth has shown to reproduce accurate IK results with imported OpenSim models, but is this still the case, when driven by muscles?

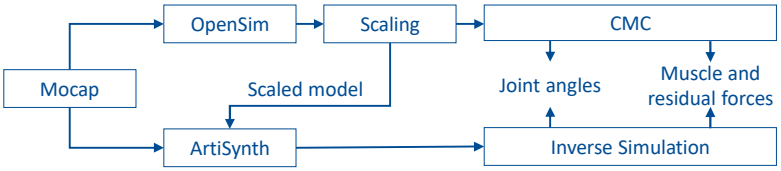
Conclusion

- ArtiSynth calculates accurate kinematics, but solves for different muscle forces
- Force differences mostly occur during preswing to midswing (50-87% of the gait cycle)

→ Producing reasonable and well fitting motions during forward dynamics is promising, further research is needed

Methods

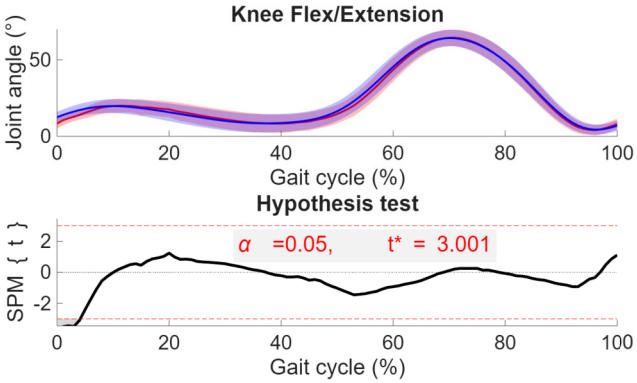
- Mocap data from 26 participants and gait2392 based OpenSim models were imported into ArtiSynth and OpenSim.
- Model output from ArtiSynth was compared to CMC computations in OpenSim 4.5 using Statistical Parametric Mapping (SPM).



Results

Joint angles

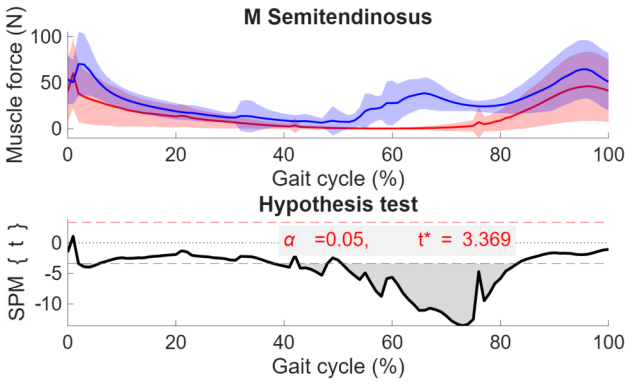
- Good agreement of joint angles (significance thresholds for two tailed t-tests are between 2.484 and 3.477).



Joint angle (SPM)	Suprathresholds	Gaitcycle and p-Values (SPM)	
Pelvic Tilt	No	-	
Pelvic Obliquity	No	-	
Pelvic Rotation	No	-	
Hip Flexion	No	-	
Hip Adduction	No	-	
Hip Rotation	No	-	
Knee Flexion	Yes	0-4%	(p = 0.042)
Ankle Flexion	Yes	1-4%	(p = 0.006)

Muscle forces

- Significant difference of muscle forces (significance thresholds for two tailed t-tests are between 3.140 and 3.369).



Muscle force (SPM)	Suprathresholds	Gaitcycle and p-Values (SPM)	
M Rect fem	Yes	0-22%	(p < 0.001)
		61-69%	(p = 0.002)
		74-87%	(p < 0.001)
M Semiten	Yes	2-5%	(p = 0.013)
		38-41%	(p = 0.019)
		43-48%	(p = 0.004)
		51-83%	(p < 0.001)
M Bic Fem long	Yes	22-81%	(p = 0.022)
M Gas med	Yes	17-18%	(p = 0.022)
		21-81%	(p < 0.001)
		83%	(p = 0.040)
		85%	(p = 0.045)
		87%	(p = 0.026)

Literature

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