

Reference

Namiki, Yuta^{1,2}; Hashizume, Satoru¹; Murai, Akihiko³; Kobayashi, Yoshiyuki³; Takemura, Hiroshi^{1,4}; Hobara, Hiroaki¹

Joint moments during sprinting in unilateral transfemoral amputees wearing running-specific prostheses

Biology Open (2019), 8(2): bio039206. DOI: 10.1242/bio.039206. [Open Access](#)

Products

3S80, 1E90

Major Findings

With 3S80 and 1E90 comparing the prosthetic to the intact side:

→ **Joint moment asymmetries between prosthetic and sound limb during sprinting suggest compensatory adaptations for replacing the biological leg with a passive prosthetic knee joint and running-specific prosthesis.**

- Significantly lower hip and knee moments on the prosthetic side in the sagittal plane may represent a compensatory strategy to prevent knee buckling during stance.
- Higher Ankle plantar-flexion moment on the prosthetic side in the sagittal plane may be attributable to a longer ground-reaction-force moment arm at the prosthetic “ankle”, rather than larger ground-reaction forces

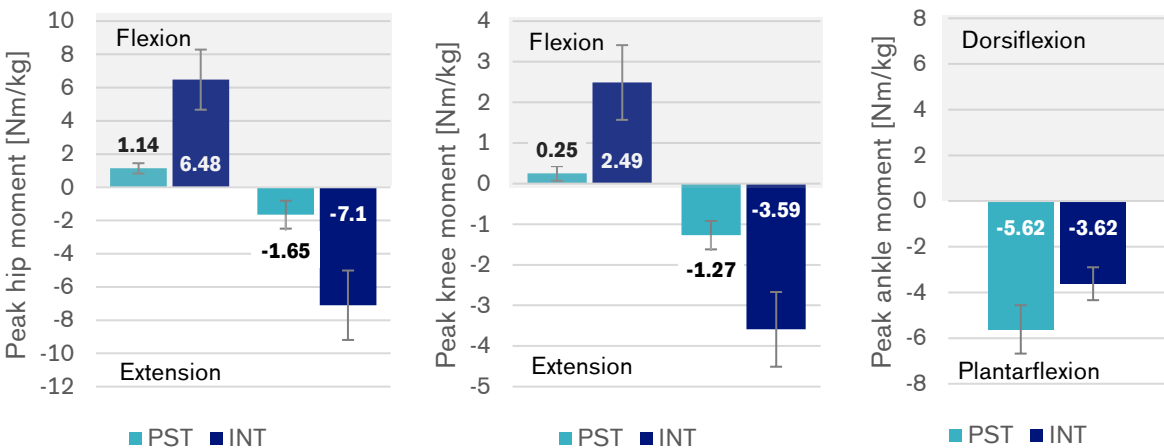


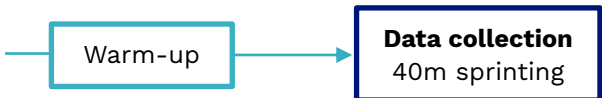
Figure 1. Peak moments for prosthetic side (PST) and intact side (INT) in the sagittal plane

Population

Subjects: 10 sprinters (6 male, 4 female)
Amputation level: unilateral transfemoral
Previous prosthesis: 3S80 + 1E90 for more than 9 months
Amputation causes: n.r.
Mean age: 32.4 ± 11.0 years
Mean height: 1.62 ± 0.09 meters
Mean weight: 57.1 ± 9.0 kg
Mean time since amputation: n.r.
MFCL: n.r.

Study Design

Prospective, observational study:



After a warm-up and familiarization, the sprinters performed maximal sprinting trials over an indoor 40m straight runway. Ground reaction forces and motion data were collected at the 22m mark, using force plates and a motion capture system. Four successful steps per leg were recorded, with adequate rest provided between trials.

Results

Activities		Participation				Body function			Other
Sprinting, running, jumping	Other sports	Leisure / recreational sports	Competitive sports	Paralympic sports	Preference, satisfaction, QoL	Biomechanics (kinematics / kinetics)	Clinical (metabolic / performance)	Medical (pain, injuries)	Technical aspects / alignment

Category	Outcomes	Results for 3S80, 1E90: prosthetic vs. intact side			Sig. ^a
Biomechanics (kinematics / kinetics)	Sprint velocity	On average: 5.84 ± 0.74 m/s (for all subjects)			n.a.
	Ground reaction force impulse [Ns/kg]	Participants accelerated, and only slightly decelerated during prosthetic and intact leg stance phase, indicating that they were sprinting at nearly maximum speed.			n.r.
			Prosthetic side	Intact side	
		Net	0.12 ± 0.07	0.00 ± 0.06	
		Braking	0.10 ± 0.03	0.21 ± 0.05	
		Propulsive	0.22 ± 0.05	0.21 ± 0.02	
	Peak joint moments [Nm/kg]	Prosthetic-side hip and knee moments were significantly lower for flexion (FL) and extension (EX), while ankle plantar-flexion moment was higher.			
	<i>Sagittal plane</i>				
		Hip FL	1.14 ± 0.31	6.48 ± 1.81	--
		EX	1.65 ± 0.84	7.10 ± 2.09	--
	Knee FL	0.25 ± 0.18	2.49 ± 0.72	--	
	EX	1.27 ± 0.35	3.59 ± 0.67	--	
	Ankle PF	5.62 ± 1.06	3.62 ± 0.92	++	
	<i>Frontal Plane</i>	Most of prosthetic-side adduction (AD) and abduction (AB) moments were significantly lower than intact-side moments.			
		Hip AD	0.48 ± 0.31	1.34 ± 0.44	--
		AB	1.27 ± 0.63	2.36 ± 1.17	--
		Knee AD	0.32 ± 0.27	0.58 ± 0.16	--
		AB	1.09 ± 0.55	1.58 ± 0.90	0
		Ankle AD	0.16 ± 0.15	0.58 ± 0.35	--
		AB	0.29 ± 0.22	0.49 ± 1.02	0
	<i>Transverse Plane</i>	Prosthetic side peak internal rotation (IR) moments were significantly lower in the for hip and knee. For the ankle, peak internal moments were significantly greater in the prosthetic side. (ER=external rotation).			

Category	Outcomes	Results for 3S80, 1E90: prosthetic vs. intact side			Sig. ^a
	Hip	IR	0.35 ± 0.17	1.12 ± 0.75	--
		ER	0.99 ± 0.48	1.29 ± 1.03	0
	Knee	IR	0.23 ± 0.10	0.59 ± 0.41	--
		ER	0.31 ± 0.14	0.34 ± 0.27	0
	Ankle	IR	0.25 ± 0.20	0.09 ± 0.08	++
		ER	0.73 ± 0.28	0.45 ± 0.43	0

^a no difference (0), positive trend (+), negative trend (-), significant (++/--), not applicable (n.a.)
significance set at $p < 0.05$; trends set at $0.1 > p > 0.05$

Author's Conclusion

“The purpose of this study was to investigate internal joint moments during sprinting in unilateral transfemoral amputees wearing RSPs. The PST joint moments were generally lower than those of the INT, except for the ankle plantar flexion and internal rotation moments. The results of the present study suggest that unilateral transfemoral amputees perform asymmetric joint moment adaptations to compensate for replacement of the biological leg with a passive prosthetic knee joint and RSP.” (Nakimi et al., 2019)

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