Reference

Thiele J*, Schöllig C*, Bellmann M**, Kraft M*

*Technische Universität Berlin, Medical Technology Group, Doverstr. 6, D-10587 Berlin, Germany.
**Otto Bock HealthCare GmbH, Department of Research, Max Näder Str. 15, D-37115 Duderstadt, Germany

Designs and performance of three new microprocessor-controlled knee joints

Biomed. Eng.-Biomed.Tech.2018.DOI:10.1515/bmt-2017-0053 (available as e-pub)

Products

C-Leg 4, Rheo Knee 3 and Plié 3

Major Findings

With C-Leg 4 compared to Rheo Knee 3 and Plié 3:

→ C-Leg 4 compared to Rheo Knee 3

Increased mean self-selected walking velocity by **0.15 m/s**
Maximum knee flexion in stance phase **3.61° higher**

→ C-Leg 4 compared to Plié 3

Microprocessor-controlled adaption of flexion and extension with C-Leg 4 during various gait speeds
→ Closer to physiological gait pattern
Clear superiority due to swing phase control

➔ No automatic flexion or extension damping with Plié 3
- Characterized by a high correlation between max. knee flexion angle and walking velocity (R^2 = 0.9).

→ All MPKs

Reliable detection of stance and swing phase
Reliable generation of joint resistance

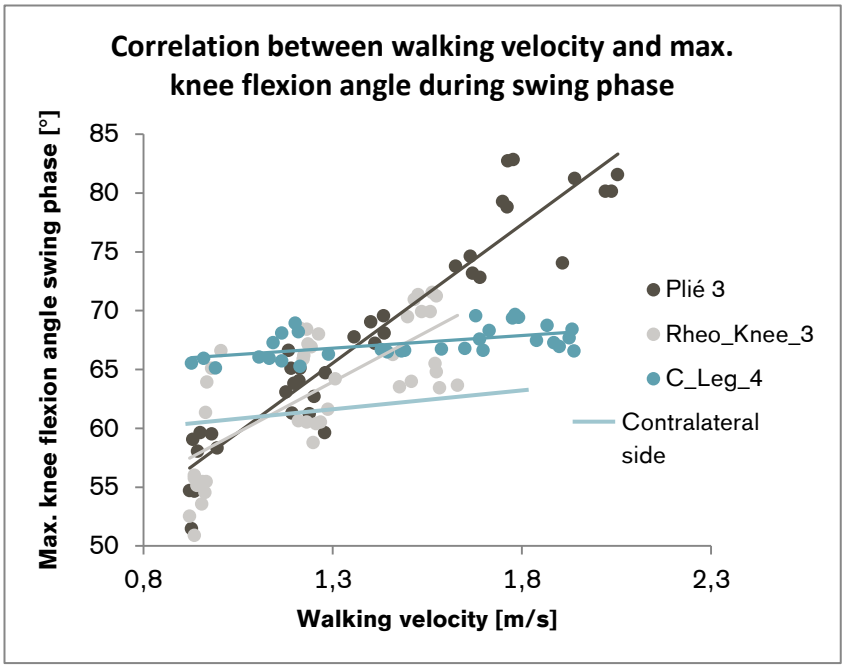


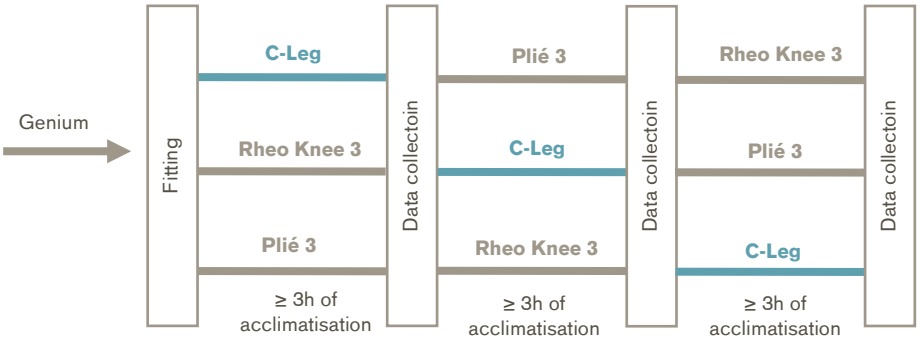
Figure 1: The graph represents the maximum knee angle [°] over walking velocity [m/s]. It is shown that the slope of the C-Leg 4 trend line is closest to the contralateral side, thus reflecting the most natural behaviour.

Population

Subjects:	Four male, unilateral, transfemoral amputees
Previous prosthesis:	Genium
Amputation causes:	not stated
Mean age:	45.8 yrs (± 12.09 yrs)
Mean time since amputation:	27.8 yrs (± 10.5 yrs)
MFCL:	K3

Study Design

Interventional, crossover design, additional technical analysis based on computer-topographical data:



Results

Activities								Participation	Environment
Level walking	**Stairs**	**Ramps, Hills**	**Uneven ground, Obstacles**	**Cognitive demand**	**Metabolic energy consump-tion**	**Safety**	**Activity, Mobility, ADLs**	**Preference, Satisfac-tion, QoL**	**Health economics**

Category	Outcomes	Results	Sig.*
Level Walking	Difference in mean self-selected gait velocity		
	C-Leg 4 - Plié 3	0.00 m/s	0
	C-Leg 4 - Rheo Knee 3	**0.15 m/s**	**++**
	Plié 3 - Rheo Knee 3	**0.15 m/s**	**++**
	Difference in maximum knee angle in stance phase		
	C-Leg 4 - Plié 3	**2.99°**	**++**
	C-Leg 4 - Rheo Knee 3	**3.61°**	**++**
	Plié 3 - Rheo Knee 3	0.62°	0
	Difference in maximum knee angular acceleration during stance phase		
	C-Leg 4 - Plié 3	**-1759°/s²**	**--**
	C-Leg 4 - Rheo Knee 3	**-264°/s²**	**-**
	Plié 3 - Rheo Knee 3	**1495°/s²**	**++**
	Correlation between max. knee flexion angle and gait velocity The physiological gait pattern is characterized by a low correlation between the max. knee flexion angle and gait velocity.		
	C-Leg 4	$R^2 = 0.26$	n.a.
	Rheo Knee 3	$R^2 = 0.53$	n.a.
	Plié 3	$R^2 = 0.9$	n.a.

* no difference (0), positive trend (+), negative trend (–), significant (++/––), not applicable (n.a.)

Author's Conclusion

"The C-Leg 4, Plié 3 and Rheo Knee 3 offer a reliable detection of stance and swing phase and the generation of joint resistance to avoid uncontrolled flexion of the knee joint. As shown in the technical analysis, only C-Leg 4 and Rheo Knee 3 allow for microprocessor-controlled adaptation of resistance to different movements and situational requirements. The Plié has manually adjustable elements that generate the resistances. This directly affects the outcome of the biomechanical analysis which examined level walking at different walking velocities. C-Leg 4 showed the most natural knee function when compared to the contralateral side and this was followed by Rheo Knee 3." (Thiele et al., 2018)