Reference	Auberger R[1,2], Breuer-Ruesch C[2], Fuchs F[2], Wismer N[2], Riener R[1,3].

[1]Sensory-Motor Systems (SMS) Lab, Institute of Robotics and Intelligent Systems (IRIS), Department of Health Sciences and Technology (D-HEST), ETH Zurich, Switzerland. [2]Ottobock Healthcare Products GmbH, Vienna, Austria.[3]Reharobotics Group, Spinal Cord Injury Center, Balgrist University Hospital, Medical Faculty, University of Zurich, Switzerland.

Smart Passive Exoskeleton for Everyday Use with Lower Limb Paralysis: Design and First Results of Knee Joint Kinetics

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Products   **C-Brace**


Major Findings
→ **Patient weight and height are insufficient criteria to estimate expected loads on a knee-orthosis system**
  Weight and height do not seem to correspond with maximum knee flexion moment.
→ **Patient's muscular status seems to play an important role.**
  Both peak flexion torque and peak knee power was lower for participants with higher residual muscle function compared to patients with lower residual muscle function.
→ **Peak loads occurring in atypical situations (e.g. stumbling) have to be considered for the system design.**
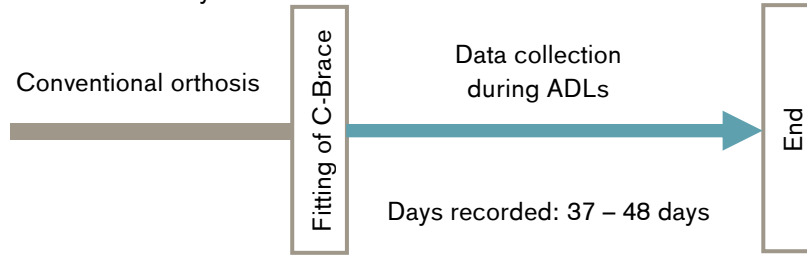

Maximum knee flexion moment for all patients

Weight [kg]

P1: 45
P2: 78
P3: 80
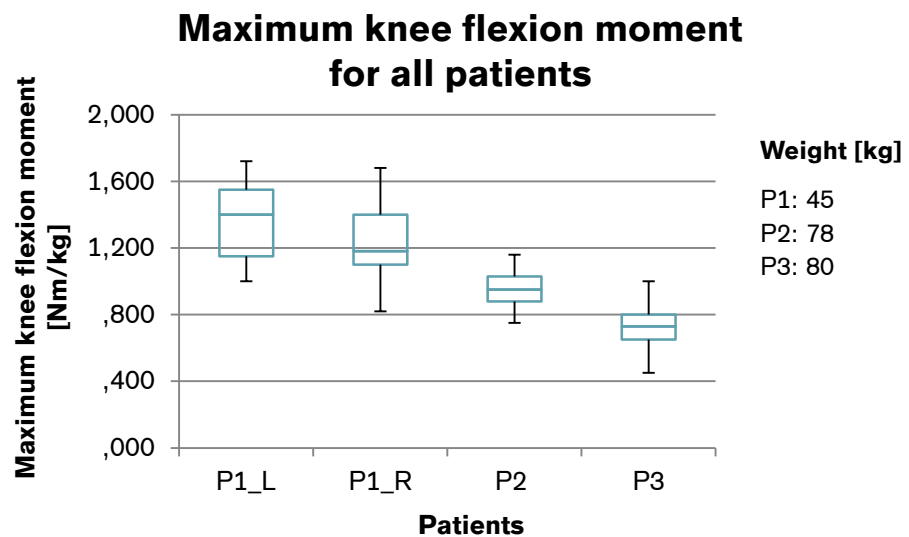
Each box plot includes the accumulated data of the maximum knee flexion moment for each recorded day for all patients.

Population

Subjects:	3 male subjects (P1, P2, P3)
Mean age:	67.7 ± 6.0 yrs
Previous orthosis:	not reported
Pathology:	P1: NF1 Recklinghausen; Muscular status: low
	P2: Post-Polio syndrome; Muscular status: intermediate
	P3: Slipped disc L3/L4, Hip TEP R, Knee TEP L
	Muscular status: high

Study Design

Interventional study:

Conventional orthosis → Fitting of C-Brace → Data collection during ADLs (Days recorded: 37 – 48 days) → End

Results

Functions and Activities						Participation
Biomechanics – Static measures	Biomechanics – Gait analysis	X-Ray	EMG	Functional tests	Clinical effects	Satisfaction

Category	Outcomes	Result for C-Brace			Sig.*
		P1	P2	P3	
Biomechanics – Gait Analysis	Days recorded	37	48	44	n.a.
	Days analysed	35	48	35	n.a.
	Median value of peak flexion torque [Nm/kg]	**1.4 (L) 1.2 (R)**	1.0	0.7	n.a.
	Median value of peak extension torque [Nm/kg]	-0.36 (L) **-0.45 (R)**	-0.37	-0,3	n.a.
	Median value of peak knee power [W/kg]	2.9 (L) 2.9 (R)	2.8	**1.5**	n.a.
	Median value of absolute acceleration [m/s^2]	71	70	**61**	n.a.
	Median value of maximum knee angle [°]	111.9 (L) 113.5 (R)	113.5	**105.4°**	n.a.

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

Author's Conclusion

"For patients with partial paralysis, patient weight and height are insufficient criteria to estimate expected loads on a supportive exoskeleton systems. The patient's muscular status seems to play an important role. Peak loads that occur at exceptional events (e.g. stumbling) have to be considered for the system design. As realistic reproduction of these events is not possible in a lab, further field research is necessary." (Auberger et al. 2018)