Reference

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Prosthetic rehabilitation for bilateral transfemoral amputees using microprocessor-controlled knees with a novel training program: A study of two cases

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Products

C-Leg 4, Kenevo

Major Findings

With bilateral C-Leg (Case 1, also started with Kenevo) and bilateral Kenevo (Case 2) after novel training program:

The cases suggest that initial training with Kenevo may contribute to a shorter rehabilitation in **bilateral transfemoral amputees**, while residual limb length may influence oxygen uptake during prosthetic ambulation (case 2 has shorter stump length).

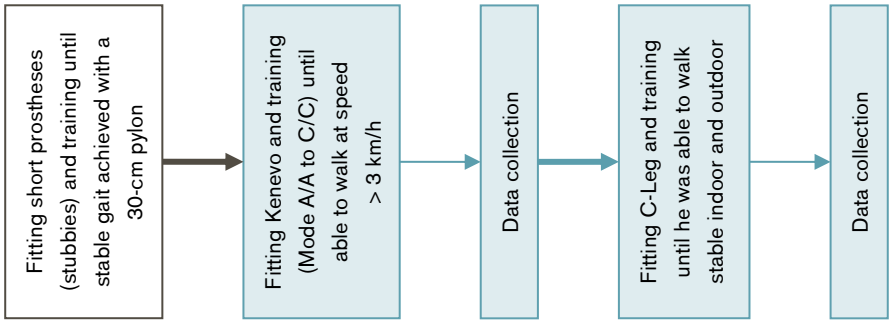
- → **Ambulatory capacity was comparable between C-Leg (case 1) and Kenevo (case 2)**
- → **Higher metabolic energy consumption with Kenevo (case 2):** higher oxygen uptake, oxygen cost and perceived exertion during gait
- → **Activities-specific Balance Confidence (ABC) scale scores were similar across both cases**

Population

Subjects:	n = 2 (both male)
Previous product:	no previous product
Amputation cause:	trauma
Amputation level:	bilateral transfemoral
Mean age:	early 20s
Mean time since amputation:	< 1 year
MFCL:	changed during case study

Study Design

Case study:



The rehabilitation program started with short prostheses (pylons without a knee joint or stubbies), upgraded to Kenevo (starting with mode A/A, progressively training to mode C/C) and then, if the patient was able to walk at a speed greater than 3 km/h (and rehab. team agreed), the patient could switch to C-Leg. Case 1 ended the rehabilitation with C-Leg and Case 2 ended with Kenevo.

Results

Functions and Activities								Participation	Environment
Level walking	**Stairs**	**Ramps, Hills**	**Uneven ground, Obstacles**	**Cognitive demand**	**Metabolic Energy Consumption**	**Safety**	**Activity, Mobility, ADLs**	**Preference, Satisfaction, QoL**	**Health Economics**

Category	**Outcomes**	**Results for:**		**Sig.[a,b]**
		C-Leg (Case 1)	**Kenevo (Case 2)**	
Level Walking	**10-meter walk test** walking speed	0.77 m/s (2.7 km/h)	0.93 m/s (3.5 km/h)	n.a.
	6 min walking test distance (speed)	365 m (3.7 km/h)	332 m (3.3 km/h)	n.a.
	Residual limb length (right / left)	24 cm / 24 cm	12 cm / 19 cm	
	Muscle strength after 1 month training	Hips: MMT4 => MMT5 Right upper limb: no impairment at baseline Left upper limb: significant impairment at baseline (MMT1-2) with no change after training.	Hips: MMT3=>MMT4+ (improved: hip flexion, abduction contractures) Right upper limb: limited ROM at baseline with MMT3, improved after training to support ADLs. Left upper limb: no impairment at baseline.	n.a.
	Progress after X months of training	X = 3: Stable walking with 30 cm pylon → change to Kenevo	X = 2: Stable walking with 30 cm pylon → change to Kenevo	n.a.
		X+3 → change to C-leg, 3.6 km/h walking speed	X+4 → steady walking on level ground, training for uneven terrain slopes, stairs took longer since patient refused walking aids; 3.0 km/h walking speed	n.a.
	After 7 months of training	With C-Leg indoor & outdoor use, with Kenevo even without cane (patient prefers C-Leg: greater stability, reduced fatigue)	--------- Change to C-Leg possible (based on gait speed), but patient denied	n.a.
Metabolic Energy Consumption	**Oxygen uptake** (consumption per min)	21.0 mL/kg/min	37.1 mL/kg/min	n.a.
	Oxygen cost (consumption per m)	0.35 mL/kg/m	0.67 mL/kg/m	n.a.
	Modified Borg scale	5 (strong)	8 (very strong)	n.a.
Preference, Satisfaction, Quality of Life (QoL)	**ABC scale**	68.8	67.5	n.a.

Category	Outcomes	Results for:		Sig.[a,b]
		C-Leg (Case 1)	Kenevo (Case 2)	

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

Author's Conclusion

"Two patients with bilateral transfemoral amputations underwent prosthetic rehabilitation through a novel prosthetic training program using Kenevo, an MPK for low-activity patients, as the first prosthesis. In one of the two cases, training with the C-Leg 4 was conducted following initial rehabilitation with the Kenevo. The findings of this study suggest that Kenevo may be a valid and effective knee joint for initial prosthetic training following bilateral transfemoral amputation. Energy expenditure during walking differed between the two patients, and the difference in the length of amputation may have influenced energy expenditure. Within the context of the rehabilitation program presented in this study, a more comprehensive evaluation may be beneficial when considering the transition from Kenevo to C-Leg 4. Such an assessment should take into account not only walking speed, but also the patient's preferences, perceived gait comfort, and the duration of training required. A multifactorial approach may improve the selection of appropriate prosthetic knee joints for individuals with bilateral transfemoral amputations; however, further research is needed to establish definitive criteria for optimal joint selection." (Toda et al., 2025)

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