

Reference

Toda, M¹; Chin, T^{1,2}; Oshima, T¹; Takase, I³; Azuma, Y³;

Oxygen Uptake during Walking in three Types of Microprocessor-controlled Prosthetic Knee Joints in a Middle-Aged Male with Bilateral Transfemoral Amputation

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Products

C-Leg, Kenevo, Hybrid Knee

Major Findings

With bilateral C-Leg and Kenevo compared to Hybrid Knee, walking with 2 canes:

→ **Reduced energy expenditure, fatigue and fear of falling while walking during prosthetic training, when using an MPK that matches the patients' physical capabilities**

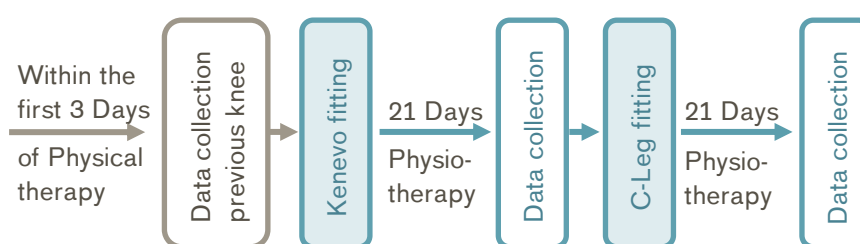
- Lower oxygen uptake (rate of consumption per minute) with C-Leg (-24%) and Kenevo (-20%) compared to the Hybrid knee
- Lower oxygen cost (rate of consumption per meter) for Kenevo (-18%) and C-Leg (-29%) compared to Hybrid knee
- Lowest subjective fatigue (Borg Scale) after walking with C-Leg
- Most stable with C-Leg as well as reduced fear of falling during walking (patient-reported experience)

Population

Subjects: 1 male
Amputation level: bilateral transfemoral
Previous knee: Hybrid knee
Amputation cause: work-related accident
Mean age: 47 yrs
Mean time since amputation: 13 yrs (amputated at age 34)

Study Design

Case study:



A bilateral transfemoral amputee was taken into rehabilitation program 11 years after his initial prosthetic prescription (because of rising fatigue and unsteadiness). He was fitted with new prosthesis according to his progress in the physiotherapy.

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	Sig. ^{a,b}										
Level Walking	6-minute walking test (6MD) distance	C-leg reached the largest distance (~9% more), but similar for all MPK's	n.a.										
		<table><tr><td>Hybrid knee</td><td>Kenevo</td><td>C-Leg</td></tr><tr><td>357 m</td><td>354 m</td><td>387 m</td></tr></table>	Hybrid knee	Kenevo	C-Leg	357 m	354 m	387 m					
	Hybrid knee	Kenevo	C-Leg										
	357 m	354 m	387 m										
Speed during 6MD	C-Leg had the fastest walking speed, but with a small difference (~9% more than Kenevo, ~6% more than Hybrid knee)	n.a.											
	<table><tr><td>Hybrid knee</td><td>Kenevo</td><td>C-Leg</td></tr><tr><td>59.5 m/min (3.6 km/h)</td><td>59.0 m/min (3.5 km/h)</td><td>64.5 m/min (3.8 km/h)</td></tr></table>	Hybrid knee	Kenevo	C-Leg	59.5 m/min (3.6 km/h)	59.0 m/min (3.5 km/h)	64.5 m/min (3.8 km/h)						
Hybrid knee	Kenevo	C-Leg											
59.5 m/min (3.6 km/h)	59.0 m/min (3.5 km/h)	64.5 m/min (3.8 km/h)											
Metabolic Energy Consumption	Oxygen cost (consumption per meter) during 6MD	Kenevo improved by 18% compared to the Hybrid knee. C-leg improved by 29% and 13% of the Hybrid knee and Kenevo, respectively.	n.a.										
		<table><tr><td>Hybrid knee</td><td>Kenevo</td><td>C-Leg</td></tr><tr><td>0.49 ml/kg/m</td><td>0.40 ml/kg/m</td><td>0.35 ml/kg/m</td></tr></table>	Hybrid knee	Kenevo	C-Leg	0.49 ml/kg/m	0.40 ml/kg/m	0.35 ml/kg/m					
	Hybrid knee	Kenevo	C-Leg										
	0.49 ml/kg/m	0.40 ml/kg/m	0.35 ml/kg/m										
Oxygen uptake (consumption per min) during 6MD	Kenevo reduced oxygen uptake by 20% compared to the hybrid knee. The C-leg has a 24% reduction compared to the hybrid knee. C-leg decreased oxygen uptake by 4.7% relative to that of Kenevo.	n.a.											
	<table><tr><td>Hybrid knee</td><td>Kenevo</td><td>C-Leg</td></tr><tr><td>29.3 ml/kg/min</td><td>23.4 ml/kg/min</td><td>22.3 ml/kg/min</td></tr></table> (measured after and before heart rate)	Hybrid knee	Kenevo	C-Leg	29.3 ml/kg/min	23.4 ml/kg/min	22.3 ml/kg/min						
Hybrid knee	Kenevo	C-Leg											
29.3 ml/kg/min	23.4 ml/kg/min	22.3 ml/kg/min											
Heart rate (beats/min)	Similar pre and post walking heart rate (HR) among the MPKs.	n.a.											
		<table><tr><td></td><td>Hybrid knee</td><td>Kenevo</td><td>C-Leg</td></tr><tr><td>HR before (beats/min)</td><td>97</td><td>95</td><td>100</td></tr><tr><td>HR after (beats/min)</td><td>139</td><td>139</td><td>136</td></tr></table> (measured before and after oxygen uptake)		Hybrid knee	Kenevo	C-Leg	HR before (beats/min)	97	95	100	HR after (beats/min)	139	139
		Hybrid knee	Kenevo	C-Leg									
	HR before (beats/min)	97	95	100									
HR after (beats/min)	139	139	136										

Category	Outcomes	Results	Sig. ^{a,b}						
	Subjective fatigue (modified Borg Scale = mBS)	Subjective fatigue smallest for C-Leg, otherwise comparable. <table><tr><td>Hybrid knee</td><td>Kenevo</td><td>C-Leg</td></tr><tr><td>7 (very strong)</td><td>7 (very strong)</td><td>5 (strong)</td></tr></table>	Hybrid knee	Kenevo	C-Leg	7 (very strong)	7 (very strong)	5 (strong)	n.a.
Hybrid knee	Kenevo	C-Leg							
7 (very strong)	7 (very strong)	5 (strong)							

^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 “Oxygen uptake during walking with three different MPKs in a middle-aged male with bilateral transfemoral amputation revealed the C-leg provided the best energy expenditure and reduced the fear of falling. The patient continued to walk with his prosthesis using C-leg in the community after discharge from the hospital. This case may imply that using appropriate MPKs for individuals with bilateral transfemoral amputations might be effective for continuing community ambulation with their prostheses, even in middle age.” (Toda et al.,2023)

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