Reference

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Choosing appropriate prosthetic ankle work to reduce the metabolic cost of individuals with transtibial amputation

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Products

BiOM T2 Ankle

Major Findings

With BiOM T2 Ankle on a treadmill with an active user group:

→ Higher power settings reduced metabolic cost of transport (COT)

- Power settings at 50% or greater resulted in reduced COT

→ Metabolically optimal power setting was on average 45% higher than the prosthetist-chosen setting

- For all participants, the power setting that minimized metabolic cost was higher than the setting selected by the prosthetist (which had been tuned to approximate healthy individual's biological ankle work)
- Cost of transport was thereby significantly reduced by 8.8 ± 4.6% on average

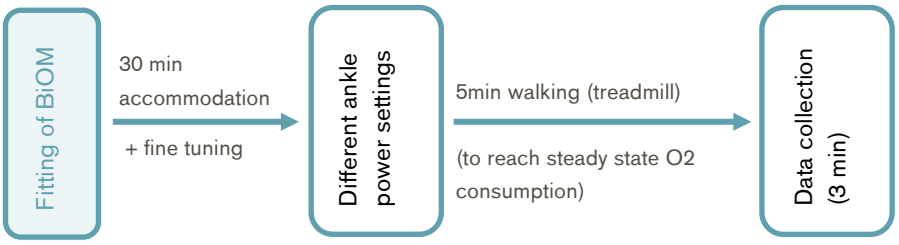
→ Individuals with transtibial amputation may achieve the lowest metabolic cost of walking when the powered ankle prostheses deliver push-off work that exceeds biological ankle norms (although the optimal power setting is highly individual)

Population

Subjects:	10 male participants (of which 1 was excluded)
Amputation level:	unilateral transtibial
Previous ankle prosthesis:	n = 9 n.a., n = 1 BiOM (T2 Ankle)
Amputation causes:	n.a.
Mean age:	41.7 ± 15.5 yrs
Mean time since amputation:	n.a.
MFCL:	K3 (n = 3), K4 (n = 7)

Study Design

Interventional, pre-post study design:



During the accommodation / fine tuning period the "prosthetist-chosen power setting" was defined. After this, participants completed six different conditions in a randomized order while walking on a treadmill. The tested conditions included power assistance levels of 0% (no power), 25%, 50%, 75%, 100% (the device's maximum), and the "prosthetist-chosen" power setting. The participants walked at least 5 min in each power setting to reach a steady-state oxygen consumption level, and then in a period of 3 min data were collected.

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 BiOM ankle	Sig.[a,b,c]
Metabolic Energy Consumption	Cost of transport (COT) (= metabolic power / (walking velocity * body weight))	Significantly lower COT in power settings with > 50% power compared to the settings of 25% or 0%.	++
		COT did not differ significantly between the higher settings (50%, 75% and 100% power).	0
		The optimal power setting, which minimized metabolic cost, reduced the COT by 8.8 ± 4.6% compared to the prosthetist-chosen setting.	n.a.
		<u>COT is moderately correlated with net ankle work</u> • Metabolic response to increasing power varied considerably between subjects → similar trends for average peak ankle power	++ n.a.
		<u>Best power setting (= lowest COT) was generally higher than prosthetist-chosen one (mean best tested setting: 86.1% ± 13.2%)</u> • Best setting for 5 out of 9 subjects: 75% power • Best setting for 4 out of 9 subjects: 100% power • Prosthetist-chosen mean power setting: 41.6% ± 8.7% • Mean participant specific difference between best and prosthetist-chosen power setting: Δ 44.6 ± 16.2%	 n.a. n.a.
	Net ankle work	<u>Ankle work increased with power setting – but not always linearly</u> • Exception: Plateau effect of net ankle work when power exceeds 50%	n.a.
		<u>Comparison between 0% vs. 25% power:</u> • 5 out of 9 subjects: +0.07 ± 0.02 J/kg more ankle work at 25% • 4 out of 9 subjects: +0.01 ± 0.00 J/kg more ankle work at 25% → similar trends for average peak ankle power	n.a.

[a] no difference (0), positive trend (+), negative trend (–), significant (++/––), not applicable (n.a.)
[b] significance set at $p < 0.05$; trends set at $0.1 > p > 0.05$
[c] effect sizes classified by authors as small (< 0.3), moderate (> 0.3 and < 0.5) or large (> 0.5)

Author's Conclusion

"The relationship between power setting, COT, and net ankle work varied considerably between subjects, possibly due to individual adaptation and exploitation of the BiOM's reflexive controller. For all subjects, the best tested power setting was higher than the prosthetist-chosen setting, resulting in a statistically significant and meaningful difference in COT between the best tested and prosthetist-chosen power settings. The results of this study demonstrate that individuals with transtibial amputation may benefit from prescribed prosthetic ankle push-off work that exceeds biological norms." (Ingraham et al., 2018)

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