

Reference

Aldridge JM, Sturdy JT, Wilken JM.

Center for the Intrepid, Department of Orthopaedics and Rehabilitation, Brooke Army Medical Center, Ft. Sam Houston, TX 78234, USA.

Stair ascent kinematics and kinetics with a powered lower leg system following transtibial amputation

Gait Posture. 2012 Jun;36(2):291-5.

Products

BiOM (Bionic powered ankle-foot prosthesis)

Major Findings

With BiOM compared to conventional energy storing and returning prosthetic feet (ESR) and able-bodied subjects (CONT)

→ Increased range of motion (ROM) of the ankle

with BiOM compared to ESR

Plantarflexion was increased by 10° with BiOM compared to ESR

→ Higher ankle push-up power

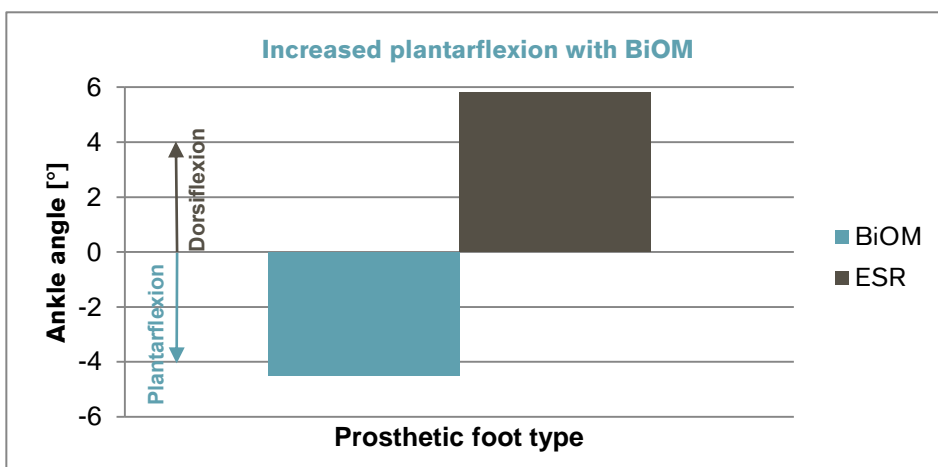
2.5 times more ankle push-up power with BiOM than with ESR

Normalization in ankle push-up power between BiOM and CONT

→ Limb asymmetries with BiOM and ESR compared to CONT

Greater prosthetic limb hip flexion and power during stance

Decreased limb knee power and extensor moment during stance



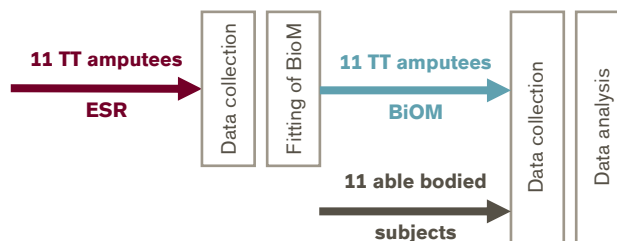
An increased plantarflexion when amputees were fitted with BiOM was observed; a positive ankle angle denotes dorsiflexion, while a negative angle denotes plantarflexion.

Population

Subjects:	Eleven unilateral transtibial amputees (one female) Eleven height, weight, and gender matched able-bodied subjects
Amputation causes:	Trauma
Mean age:	Amputees: 30 ± 5 years CONT: 23.4 ± 3.9 years
Mean height:	Amputees: 1.8 ± 0.1 m CONT: 1.8 ± 0.1 m
Mean body mass:	Amputees: 94.7 ± 7.1 kg CONT: 93.0 ± 10.6 kg

Study Design

Interventional, pre-to post design:



The two sessions were separated by an average of 43.4 (SD 18.1) days to allow acclimation to the BiOM. The transtibial amputees ascended the instrumented stair-case in a step-over-step manner at two different cadences: self-selected and controlled cadence of 80 steps/min. A controlled cadence condition was included to prevent potential speed effects from influencing between-device (BiOM and ESR) comparison. The able-bodied subjects performed an identical biomechanical stair ascent assessment.

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 vs ESR vs CONT	Sig.*
Stairs (Stair ascent)	Transitioning onto the stair (Pull-up)	<u>Knee:</u> Limb asymmetries, due to significantly greater knee extensor moment and knee power of the intact limb when compared to the prosthetic limb with BiOM or ESR.	--
		Furthermore, the prosthetic limb knee extensor moment and knee power were significantly lower than CONT during pull-up.	--
		<u>Hip:</u> Limb asymmetries, due to a significantly more flexed hip and increased hip joint power with the prosthetic limb when compared to intact limb.	--
	Transitioning off the stair (Push-up)	<u>Plantarflexion of the ankle:</u> The plantarflexion was significantly increased by 10° with BiOM compared to ESR.	++
		BiOM showed a significantly less plantarflexion than CONT.	--
		<u>Plantarflexor moment:</u> The intact limb of the amputees produced a significantly higher plantarflexor moment than the prosthetic limb (with BiOM and ESR) No differences were observed between the prosthetic limb (with BiOM and ESR) and CONT.	0
	<u>Push-up power:</u> With BiOM, the amputees generated an approximately 2.5 times increased push-up power than with ESR.	++	

Category	Outcomes	Results for BiOM vs ESR vs CONT	Sig.*
		No significant difference in push-up power was observed between the prosthetic limb while using the BiOM device and CONT.	0
	Swing	<u>Dorsiflexion of the ankle:</u> The dorsiflexion was significantly decreased with BiOM compared to ESR.	--
		The hip of the prosthetic limb (with BiOM and ESR) was more flexed than that of the intact limb during swing.	--

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

Author's Conclusion

"The PowerFoot BiOM restored ankle power and produced a large increase in ankle ROM during STA in persons with TTA. However, while using the BiOM, persons with TTA continued to use a hip strategy to ascend the stairs. Addition of ankle power should not be the sole aim of device developers. Additional device specific training and design modifications may be needed to allow individuals with TTA to fully utilize the additional capabilities of the device." (Aldridge et al., 2012)

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