Reference

Grabowski AM, D'Andrea S.

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Effects of a powered ankle-foot prosthesis on kinetic loading of the unaffected leg during level-ground walking

J Neuroeng Rehabil. 2013 Jun 7;10:49.

Products

BiOM (Bionic powered ankle-foot prosthesis)

Major Findings

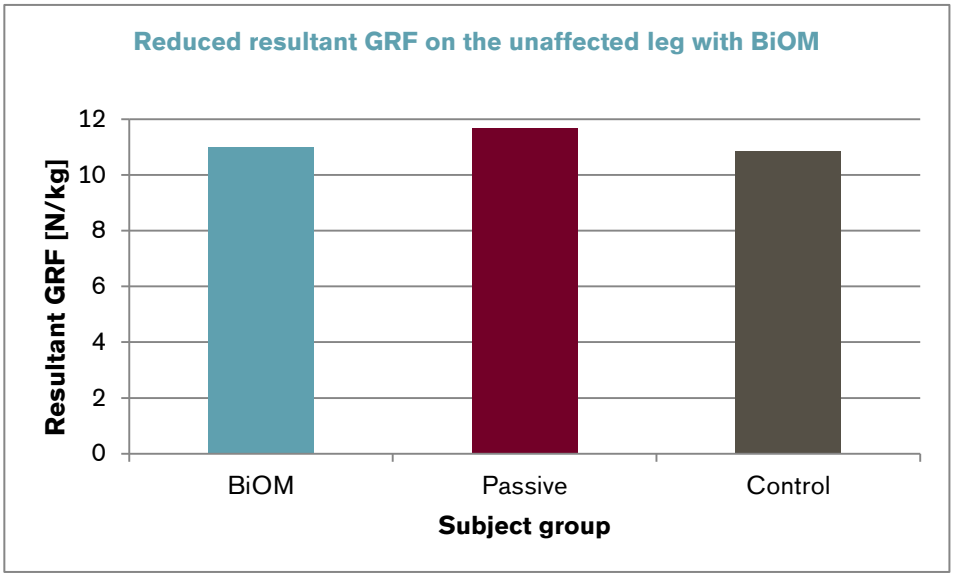
With BiOM compared to conventional passive-elastic feet (Passive) and non-amputees (Control):

→ **Reduction of the resultant ground reaction forces (GRF) acting on the unaffected**

Decrease by 2.1% to 10.7% (for walking speeds from 0.75 to 1.5 m/s) with BiOM compared to Passive

→ **BiOM decreased the external adduction moment (EAM) on the unaffected knee**

Reduction by 20.6% and 12.2% (for walking speeds of 1.5 and 1.75 m/s, respectively) with BiOM compared to Passive



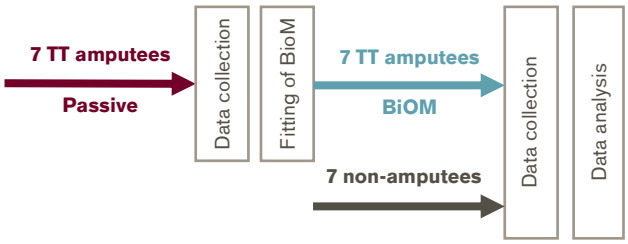
The average resultant first peak GRF on the unaffected leg for all walking speeds (0.75 – 1.5) was calculated; BiOM presented a reduced resultant GRF compared to passive feet.

Population

Subjects:	Seven unilateral, transtibial amputees (Seven male) Seven non-amputees (Control)
Previous prosthetic feet:	Flex-Foot, Ossur (3); Axtion, Otto Bock (1); Venture, College Park (1); Renegade, Freedom Innovations (1); Limb Logic, Ohio Willow Wood (1)
Amputation causes:	Trauma
Mean age:	Amputees: 45 ± 6 yrs Control: 48 ± 7 yrs
Mean time since amputation:	21.6 ± 11.6 yrs
MFCL:	K3

Study Design

Interventional, pre- to post design:



Subjects with an amputation completed two experimental walking sessions; one using their own passive-elastic foot and one using the powered ankle-foot prosthesis (acclimation session of at least 2 hours). Non-amputee subjects completed one experimental session.

Each subject walked at 0.75, 1.00, 1.25, 1.50, and 1.75 m/s, while the stiffness and power delivery of the powered prosthesis was adjusted so that prosthetic ankle angle at toe-off and net positive mechanical work matched average biological ankle data.

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 Passive vs Control**	**Sig.***
Level Walking	Unaffected leg: 1st peak ground reaction force (GRF) [N/kg]	**For all walking speeds from 0.75 to 1.5 m/s, amputees with BiOM showed a significant decrease of the 1st peak of GRF by 2.1% to 10.7% when compared to Passive.**	**++**
		There were no significant differences between BiOM and Control for the 1st peak GRF while walking with different walking speeds.	0
	Unaffected leg: GRF rate [N/kg/s]	There were no significant differences between BiOM, Passive and Control while walking, except for one specific walking speed: **For 1.25 m/s, Control showed significant lower GRF rates than amputees with BiOM (+30.3%) or Passive (+49,1%).**	0 **––**
	Unaffected leg: 1st peak external knee adduction moment (EAM) [Nm/kg]	**For the two fastest walking speeds (1.5 and 1.75 m/s), the BiOM reduced the 1st peak of the EAM significantly by 20.6% and 12.2%, respectively, when compared to Passive.**	**++**
		Apart of that, there were no significant differences between BiOM, Passive and Control while walking with different walking speeds.	0
	Unaffected leg: knee EAM rate [Nm/kg/s]	There were no significant differences between BiOM, Passive and Control in knee EAM rate for all walking speeds.	0

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

Author's Conclusion

"A passive-elastic prosthesis cannot emulate normative biological function during the stance phase of walking; thus people with a lower-extremity amputation employ compensatory mechanics and have a higher incidence of musculoskeletal injury, specifically knee osteoarthritis in their unaffected leg. A biomimetic prosthesis could mitigate the risk of knee osteoarthritis by decreasing unaffected leg forces and knee moments. In this investigation, we found that when people with a unilateral transtibial amputation due to trauma and K3 level of ambulation used a powered ankle-foot prosthesis during level-ground walking over a range of speeds, they reduced the peak resultant force and knee adduction moment on their unaffected leg compared to when they used their own passive-elastic prosthesis. At the walking speed closest to preferred, subjects with an amputation using a powered ankle-foot prosthesis reduced their unaffected peak knee EAM by over 20%. A significant reduction in peak knee EAM has the potential to decrease the risk of knee osteoarthritis. Based on these results, we conclude that a biomimetic powered ankle-foot prosthesis could potentially limit musculoskeletal stress to the contralateral leg during walking, thus decreasing the risk of secondary injury in people with a lower-extremity amputation." (Grabowski and D'Andrea, 2013)