Reference

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Mechanical Adaptations in Walking Using Carbon Fiber Ankle Foot Orthoses for Patients with Peripheral Artery Disease

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Open Access.

Products

WalkOn Reaction (WOR)

Major Findings

With the ankle foot orthoses (AFO) WalkOn Reaction compared to no orthosis:

→ Significantly reduced ankle flexor power when walking with WOR through restricted ankle mobility and reduction in ankle plantar flexor moment.

- Significant reduction in dorsiflexion with an average decrease of 30% at both points of time ($p<0.001$)
- Significant reduction in plantar flexion at toe off with an average decrease of 56% at both points of time ($p<0.001$)
- Significant reduction in ankle plantar flexor moment by 3% at both points of time ($p=0.037$)
- Significant reduction in ankle plantar flexor power with an average decrease
- of 38% at both points of time ($p<0.001$)

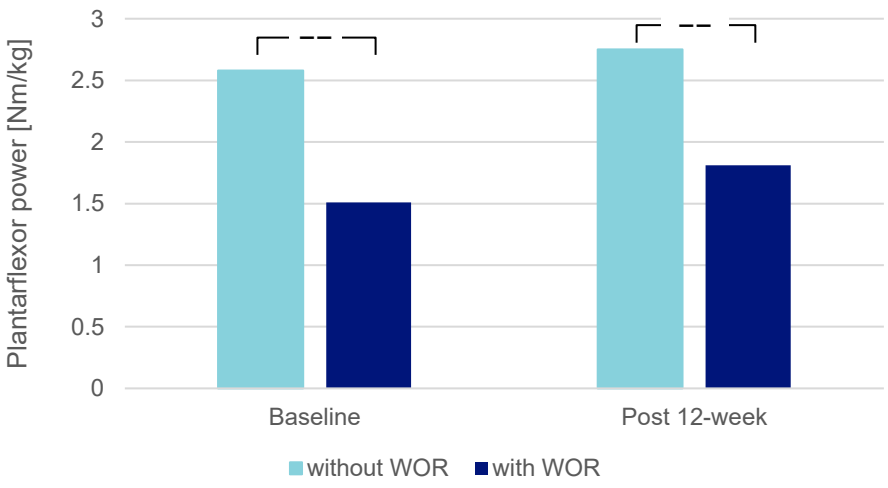


Figure 1: Peak ankle plantar flexor power while walking with WOR compared to walking without WOR at the baseline measurement and after 12 weeks of using the WOR (–– indicates significant reduction)

→ Plantar flexor muscle activation pattern was maintained when adding WOR ($p>0.05$)

- Suggests that using WOR is unlikely to harm the plantar flexor muscles over time.

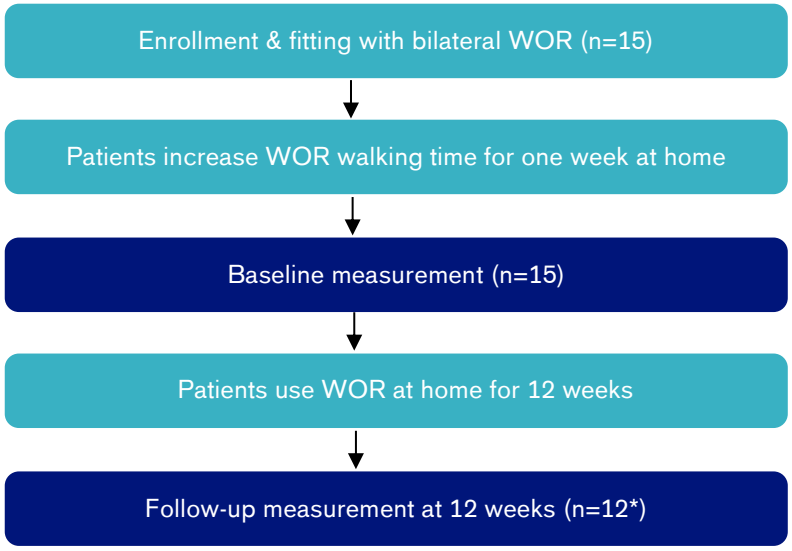
Population

Subjects (initial enrollment):	15 (9 males, 6 females)
Subjects (left at follow-up measurement):	12 (7 males, 5 females)
Clinical condition:	peripheral artery disease (PAD), calf claudication as a limiting factor for walking ability

Calf claudication symptoms:	6 unilateral, 9 bilateral
Mean age:	67.4 ± 12.4 years
Mean height:	1.72 ± 0.08 meters
Mean bodyweight:	78.1 ± 23.2 kg

Study Design

Repeated measures cohort study:



*3 patients dropped out

Measurements included self-paced gait analysis with electromyographic (EMG) measurement of the musculus triceps surae. The testing order of the two conditions walking with or without WOR was randomized. A single representative leg was selected for analysis at both time points alternating between right and left. For testing, patients wore shoes which they typically used with their WOR. The perception of pain was not investigated.

Results

Functions and Activities						Participation	Environment
Biomechanics – Static Measurement	Biomechanics – Gait analysis	X-Rays	EMG	Functional tests	Clinical effects	Satisfaction	Health Economics

Category	Outcomes	Results for without and with WalkOn Reaction	Sig.[a]
Biomechanics – Gait analysis – Baseline measurement (n=15)	Peak ankle kinematics	At the baseline measurement peak dorsiflexion and plantarflexion as well as the peak ankle plantar flexor power were significantly reduced when walking with WOR compared to walking without.	

	Without WOR	With WOR	
Peak dorsiflexion during stance [°]	13.1 ± 3.0	8.8 ± 3.2	--

Category	Outcomes	Results for without and with WalkOn Reaction			Sig.[a]
		Peak plantarflexion at toe off [°]	10.0 ± 5.7	3.7 ± 3.2	--
		Peak ankle plantar flexor power [W/kg]	2.58 ± 0.98	1.51 ± 0.56	--
		Peak ankle plantar flexor moment [Nm/kg]	1.29 ± 0.18	1.25 ± 0.17	0
	Self-selected gait speed	No significant difference			0
Biomechanics – Gait analysis – Follow-up measurement (n=12)	Peak ankle kinematics	At the follow-up measurement at 12 weeks peak dorsiflexion and plantarflexion as well as the peak ankle plantar flexor power and flexor moment were significantly reduced when walking with WOR compared to walking without.			
			Without WOR	With WOR	
		Peak dorsiflexion during stance [°]	12.4 ± 3.5	9.0 ± 2.7	--
		Peak plantarflexion at toe off [°]	10.4 ± 6.7	5.3 ± 3.6	--
		Peak ankle plantar flexor power [W/kg]	2.75 ± 1.03	1.81 ± 0.78	--
		Peak ankle plantar flexor moment [Nm/kg]	1.33 ± 0.24	1.29 ± 0.22	--
	Self-selected gait speed	No significant difference			0
Biomechanics – Gait analysis – Interactions and main effects of time* and WOR use**	Gait mechanics	Walking with WOR lead to a change in gait mechanics, independent of the testing time point. The WOR effects involved significant reduction in the peak dorsiflexion, plantarflexion, plantar flexor moment and plantar flexor power. Gait speed remained unchanged. The WOR related effects were stable across both testing sessions.			
	Interaction of main effect of time and WOR use	Not significant			0
	Within-subjects main effects for testing time	Not significant			0
	Main effect of WOR use condition for gait speed	No significant difference			0
	Main effect of WOR use condition for gait mechanics:	Peak dorsiflexion	Significant reduction when walking with WOR		--
		Peak plantarflexion	Significant reduction when walking with WOR		--

Category	Outcomes	Results for without and with WalkOn Reaction		Sig.[a]
		Plantar flexor moment	Significant reduction when walking with WOR	--
		Plantar flexor power	Significant reduction when walking with WOR	--
		→wearing the WOR consistently changed the ankle mechanics independent of whether at baseline or after 12 weeks		
EMG – Peak triceps surae muscle recruitment	Baseline testing	No significant difference		0
	Follow-up testing	No significant difference		0

[a] no difference (0), positive trend (+), negative trend (–), significant (**++/––**), not applicable (n.a.)
*main effect of time: this examines whether the outcome changed from baseline to the 12-weekollow-up, regardless of the participants walking with or without the WOR
Main effect
**main effect of WOR use: this examines whether the outcomes differed between walking with WOR vs. without WOR, regardless of the testing time point

Author's Conclusion

"Adding WOR limits peak ankle motion and joint power during self-paced walking while maintaining their walking speed. These gait adaptions were maintained over 12 weeks of walking practice time. A resulting decrease in plantar flexor power while maintaining gait speed may provide the mechanism by which WOR can delay claudication onset which are major barrier to PAD walking programs. Calf muscle recruitment was maintained when adding the WOR which suggests sufficient muscle exertion could exist to maintain muscle integrity with sustained WOR use." (Minzer et al., 2023)

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