
Reference

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Effectiveness of Ankle-Foot Orthoses for Patients with Weakness of the Plantarflexors and Dorsiflexors: Biomechanical Comparison of Different Orthotic Concepts

Journal of Prosthetics and Orthotics 37(3):p 193-202, July 2025.

DOI: 10.1097/JPO.0000000000000546. [Open Access](#)

Products

Nexgear Tango

Major Findings

With Nexgear Tango, a reactive-dynamic ankle joint with adjustable spring modules (RDA), compared to a conventional hinged ankle joint with rigid stops (in form of the Nexgear Tango configured with fixed stops) (CAJ) and WalkOn Reaction, a joint-less carbon-fibre orthosis (JLO):

→ **Higher ROM and higher peak joint moment of the ankle, which enable a joint ankle and moment pattern closer to able-bodied controls with RDA**

- Significantly higher dorsiflexion in the stance phase by 40% during level walking ($p=0.02$), by 84% while ascending slope ($p=0.02$) and by 47% while descending slopes ($p=0.046$) with RDA compared to CAJ.
- Significantly higher plantarflexion angle by 86% during level walking ($p=0.02$), by 88% while ascending slope ($p=0.02$) and by 94% while descending slopes ($p<0.05$) with RDA compared to CAJ.
- Significantly higher mean ankle flexion angles by 7% while standing downhill with RDA compared to JLO ($p=0.03$).
- Significantly lower maximum knee extension moment while ascending slopes by 29% with RDA compared to CAJ ($p=0.045$).
- Significantly higher hip angles by 19% while descending a slope with RDA compared to CAJ ($p<0.05$).

→ **Reduced compensatory crouch or hyperextension movements in the knee joint with RDA compared to CAJ**

- Walking down a slope, ankle dorsiflexion and plantarflexion is closer to normative values observed in the able-bodied control group.

→ **Smoother curve of ankle power during gait cycle and significantly higher peak power output at push-off with RDA than with CAJ**

- Significant higher ankle power at push-off by 125% during level walking ($p=0.02$) and by 99% while ascending a slope ($p=0.027$ with RDA compared to CAJ).

→ **Higher Preference for the RDA over all other configurations**

- RDA was rated better by the participants than CAJ and JLO in all three areas (standing uphill / downhill / walking tasks).

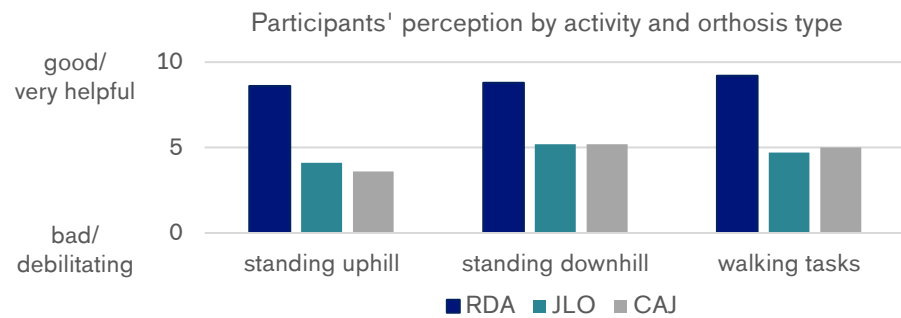
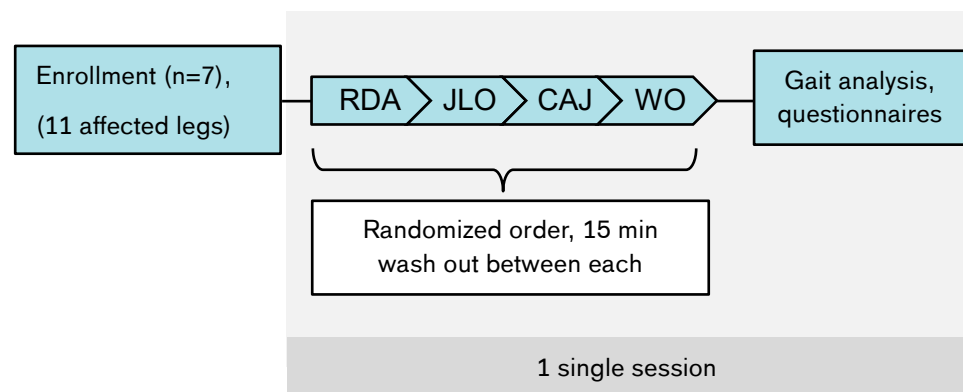


Figure 1: Participants perception of standing uphill, standing downhill and during walking tasks of three orthosis configurations. Legend: Nexgear Tango (RDA), WalkOn Reaction jointless orthosis (JLO), Conventional orthosis (CAL)

Population	Subjects:	7 adults (6 male, 1 female)
	Mean age:	57 ± 15.2 years
	Mean height:	1.85 ± 0.10 m
	Mean body weight:	91.0 ± 15.4 kg
	Previous orthosis:	Reactive-Dynamic Ankle Joint System (RDA)-AFO for 2.4 ± 1.3 years
	Clinical conditions:	Condition post disc prolapse surgery (2), polyneuropathy (1), lower leg paraplegia with plantarflexion weakness (1), hemiparesis post brain haemorrhage (1), spinal canal stenosis (1), and condition after diving accident with rare muscle disease (1)
	Affected side:	3 unilateral, 4 bilateral (11 affected legs)

Study Design Randomized, comparative:



Participants wore their own footwear.

The control group was nonmatched and consisted of over 100 participants between 20 and 65 years old with no impairments concerning their gait.

RDA = Reactive-Dynamic Ankle Joint System in form of the Nexgear Tango

JLO = Jointless Orthosis in the form of the WalkOn Reaction

CAJ = Conventional hinged ankle joint with rigid stops in the form of Nexgear Tango with ROM limited by rigid dorsiflexion and plantarflexion stops

WO = Control situation without an orthosis

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 RDA vs. JLO vs. CAJ vs. WO				Sig. ^a (RDA vs. others)
Biomechanics – Standing on level ground	While standing on level ground, significantly higher mean ankle flexion angle were measured with the RDA and CAJ compared to the JLO and the control situation without orthosis (WO), and significantly higher hip flexion angles with the RDA compared to WO.					
	Mean ankle flexion angles [°]	RDA 115.9 ± 3.8	JLO 109.8 ± 3.4	CAJ 116.9 ± 3.8	WO 108.7 ± 3.6	++ vs. JLO, WO
	Knee flexion angles [°]	No significant results				0
	Hip flexion angles [°]	RDA 93.5 ± 3.1*	JLO 93.7 ± 3.1	CAJ 92.3 ± 3.4	WO 91.6 ± 3.5*	++ vs. WO
Biomechanics – Standing uphill	While standing uphill, similar effects were observed to the level ground situation: significantly higher ankle flexion angles were measured with each RDA and CAJ compared to WO and with RDA and CAJ compared to the JLO.					
	Mean ankle flexion angles [°]	RDA 108.5 ± 3.9	JLO 103.3 ± 3.2	CAJ 112.3 ± 6.1	WO 98.6 ± 3.4	++ vs. JLO, WO
	Knee flexion angles [°]	No significant results				0
	Hip flexion angles [°]	No significant results				0
Biomechanics – Standing downhill	While standing downhill significantly lower ankle flexion angles were measured with the JLO compared to the CAJ.					
	Mean ankle flexion angles [°]	RDA 122.7 ± 3.6	JLO 114.7 ± 6.1	CAJ 125.1 ± 5.1	WO 118.6 ± 3.5	++ vs. JLO
	Knee flexion angles [°]	No significant results				0
	Hip flexion angles [°]	No significant results				0
Biomechanics - Level walking	When walking on level ground, the RDA showed significantly higher values than the CAJ in terms of maximal dorsiflexion and maximum plantarflexion angles, as well as greater performance in the ankle joint power at push-off.					
	Gait speed [m/s]	RDA 1.2 ± 0.3	JLO 1.1 ± 0.2	CAJ 1.1 ± 0.3	WO 1.1 ± 0.3	0

Category	Outcomes	Results for RDA vs. JLO vs. CAJ vs. WO				Sig. ^a (RDA vs. others)
		RDA	JLO	CAJ	WO	
	Maximal dorsiflexion angle in stance phase [°]					++ vs. CAJ
		20.1 ± 3.4	20.1 ± 2.9	14.4 ± 2.6	25.2 ± 3.7	
	Final plantarflexion angle at push-off [°]					++ vs. CAJ
		16.4 ± 2.5	15.6 ± 2.6	8.8 ± 1.2	21.8 ± 5.3	
	Max. plantarflexion moment at push-off [Nm/kg]	1.3 ± 0.3	1.3 ± 0.2	1.3 ± 0.2	1.1 ± 0.3	0
	Max. ankle power at push-off [W/kg]					++ vs. CAJ
		1.8 ± 0.8	1.6 ± 0.6	0.8 ± 0.3	1.7 ± 0.9	
	Knee extension range of motion during stance [delta in°]	18.6 ± 4.7*	16.4 ± 5.3	16.9 ± 6.9	15.2 ± 6.3*	++ vs. WO
	Max. knee extension moment during stance [Nm/kg]	0.3 ± 0.3	0.3 ± 0.3	0.5 ± 0.2	0.2 ± 0.3	0
	Hip extension range of motion during stance [delta in°]					++ vs. WO
		37.9 ± 5.2	38.8 ± 4.3	38.2 ± 4.6	36.1 ± 6.0	
	Max. hip extension moment during stance [Nm/kg]	1.0 ± 0.3	1.0 ± 0.3	1.0 ± 0.3	1.0 ± 0.3	0
Biomechanics – Ascending slope	When walking up the slope, the same significant differences between RDA and CAJ were observed as when walking on level ground. In addition, the knee-extending moment was significantly smaller.					
		RDA	JLO	CAJ	WO	
	Gait speed [m/s]	0.9 ± 0.4	0.8 ± 0.3	0.8 ± 0.3	0.8 ± 0.3	0
	Ankle dorsiflexion angle during stance [°]					++ vs. CAJ
		16.7 ± 2.8	16.0 ± 3.0	9.1 ± 1.9	23.6 ± 5.3	
	Final plantarflexion angle [°]					++ vs. CAJ
		17.9 ± 2.3	16.4 ± 3.9	9.5 ± 4.1	27.1 ± 14.3	
	Maximal ankle joint moment [Nm/kg]	1.3 ± 0.23	1.36 ± 0.2*	1.24 ± 0.19*	0.95 ± 0.40	++ (JLO vs. CAJ)

Category	Outcomes	Results for RDA vs. JLO vs. CAJ vs. WO				Sig. ^a (RDA vs. others)
Biomechanics - Descending slope	Maximal knee extension moment [Nm/kg]	0.50 ± 0.11*	0.51 ± 0.23	0.70 ± 0.21*	0.16 ± 0.25	++ vs. CAJ
	Max. ankle joint power at push-off [W/kg]					++ vs. CAJ
		1.29 ± 0.74	1.50 ± 1.10	0.65 ± 0.23	1.17 ± 0.91	
	When walking down the slope, similar significant differences between RDA and CAJ were observed. Higher maximal dorsiflexion and maximum plantarflexion angles were measured as well as a significantly larger hip angle.					
		RDA	JLO	CAJ	WO	
	Dorsiflexion during stance [°]					++ vs. CAJ
		26.9 ± 5.9	24.5 ± 4.7	18.3 ± 4.1	35.9 ± 4.5	
	Maximal plantarflexion at push-off [°]					++ vs. CAJ
		18.0 ± 4.2	17.1 ± 2.7	9.3 ± 2.5	28.2 ± 10.8	
	Hip flexion/extension angle [°]					++ vs. CAJ
Satisfaction	On a scale 1 ("bad"/debilitating)-10 ("good"/very helpful), the RDA was rated the best in all three categories (standing uphill/downhill, walking tasks).					
		RDA	JLO	CAJ		
	Standing uphill	8.6	4.1	3.6		n.a.
	Standing downhill	8.8	5.2	5.2		n.a.
	Walking tasks	9.0-9.4	4.5-5.0	4.5-5.5		n.a.

^a no difference (0), positive trend (+), negative trend (–), significant (++/–), not applicable (n.a.); significance set at $p < 0.05$; trends set at $0.1 > p > 0.05$

*significant difference between specific configurations

Author's Conclusion

“Overall, the results of this study showed significantly superior results in almost all gait parameters with RDA compared with CAJ. From a biomechanical perspective, JLO and RDA seemed to show similar benefits in the motion tasks tested within this study, suggesting a JLO may be sufficient for patients with such or similar activities in their day-to-day life and a comparable level of muscle weakness. However, subjective perception analysis implied that RDA may be favorable for more demanding and strenuous activities, such as ascending or descending longer and steeper inclines, walking long distances or across uneven surfaces. RDAs may therefore be primarily suitable for highly active patients with high expectations toward their orthotic care” (Burkhardt et al., 2025)

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