

Reference

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The influence of dynamic carbon spring orthoses on movement in spina bifida patients

[original: Der Einfluss von dynamischen Karbonfeder-Orthesen auf den Bewegungsablauf bei Spina Bifida Patienten]

Orthopädie-Technik (2007), 58(11), 816-822.

Products

Carbon Ankle Seven (CA7)

Major Findings

With CA7 assembled posteriorly (established principle) or anteriorly (new principle) and compared to no ankle foot orthosis (barefoot):

- **Both CA7 orthosis configurations significantly improved gait performance compared to barefoot walking, as reflected by 23% higher walking speed, 17-37% longer step length, and 4% decreased cadence compared to barefoot.**
- **Ankle joint kinematics were significantly influenced by orthosis configuration, with the CA7 anterior producing greater initial plantarflexion and peak dorsiflexion during stance than the CA7 posterior design.**
- **No significant differences between CA7 anterior and CA7 posterior were observed for spatiotemporal gait parameters.**
- **Overall, both CA7 orthoses reduced pathological gait characteristics and shifted gait patterns toward physiological reference values observed in healthy subjects.**
- **Both orthosis concepts showed only limited ability to improve frontal-plane knee instability; no relevant differences were observed between the anterior and posterior spring designs.**

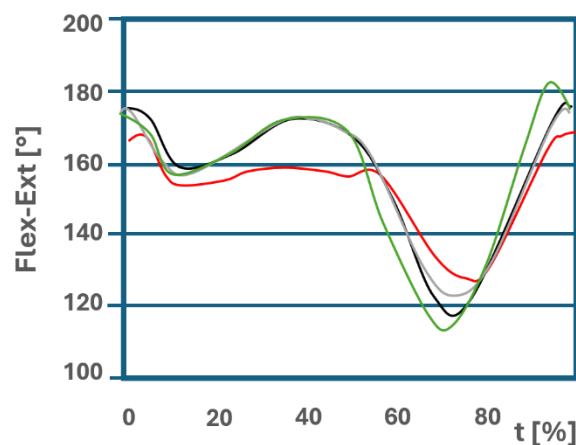
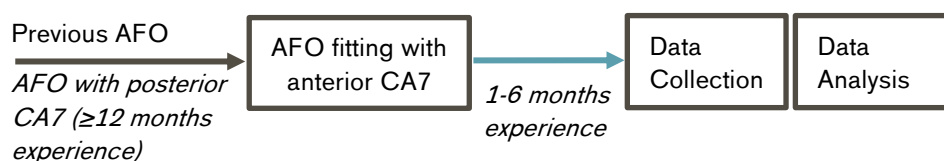


Figure 1. Mean knee flexion-extension angles (green: healthy control group, red: barefoot, black: AFO with anterior spring, grey: AFO with posterior spring) (Figure recreated based on visual data extracted from the published graph. Exact underlying values were not available and should be considered approximate.).

Population	Patients	Healthy controls ^[1]
Subjects:	6 (sex: n.r.) with Spina bifida	30 (sex: n.r.)
Mean Age:	13.7 ± 5.3 years (range 9 – 20 years)	28 ± 5 years
Mean weight:	53.7 ± 23.5 kg	71 ± 9 kg
Mean height:	156.2 ± 20.9 cm	175 ± 6 cm
Previous orthoses:	AFOs (bilateral) with CA7 posteriorly assembled for at least 12 months	none

Study Design

Comparative, randomised, biomechanical study:



Data Collection: 3D gait analyses (CA7 posterior, CA7 anterior, barefoot; in randomised order) on level ground with force plates (6-10 runs per test condition).

Data Analysis: Comparisons between CA7 anterior, CA7 posterior, without AFO and control group (30 healthy subjects collected in an earlier study [1])

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	Sig. ^a						
Biomechanics – Gait analysis	Walking speed [m/s]	Significantly increased walking speed with both orthoses compared to barefoot and closer to values of control group.	++ (CA7 compared to barefoot)						
		<table> <tr> <th>CA7 anterior</th><th>CA7 posterior</th><th>barefoot</th><th>control group</th></tr> <tr> <td>1.23 ± 0.10</td><td>1.23 ± 0.13</td><td>1.00 ± 0.13</td><td>1.55 ± 0.16</td></tr> </table>		CA7 anterior	CA7 posterior	barefoot	control group	1.23 ± 0.10	1.23 ± 0.13
CA7 anterior	CA7 posterior	barefoot	control group						
1.23 ± 0.10	1.23 ± 0.13	1.00 ± 0.13	1.55 ± 0.16						
	Stride length [m]	Significantly increased stride length with both CA7 configurations relative to barefoot and closer to values of control group. With CA7 posterior the stride length was increased even more in the right foot and, thus, shows a more asymmetrical gait than with CA7 anterior.	++ (CA7 compared to barefoot)						

Category	Outcomes	Results				Sig. ^a	
			CA7 anterior	CA7 posterior	barefoot	control group	
		Right side	0.63 ± 0.07	0.70 ± 0.1	0.51 ± 0.03	0.83 ± 0.16	
		Left side	0.64 ± 0.07	0.56 ± 0.09	0.48 ± 0.07	0.83 ± 0.16	
	Cadence (step frequency) [st/min]	With CA7 the cadence was significantly reduced compared to barefoot and closer to values of control group.				-- (CA7 compared to barefoot)	
			CA7 anterior	CA7 posterior	barefoot	control group	
			116 ± 13	117 ± 16	122 ± 17	109 ± 11	
	Ankle joint kinematics	- Compared to barefoot walking, both orthosis configurations reduced pathological ankle motion. - The anterior CA7 configuration showed significantly greater initial plantarflexion and dorsiflexion than the posterior configuration, indicating a more physiological gait. - The posterior CA7 configuration showed a tendency toward higher push-off dynamics.					
	Changes (ΔΦ) in the flexion-extension angle in the upper ankle joint during stance phase for:	With the anterior CA7 the initial plantar flexion and dorsiflexion were significantly higher than compared to the posterior CA7 configuration.					
			CA7 anterior	CA7 posterior	barefoot	control group	
		Initial plantar flexion	8.9	4.7	15.9	10.1	++ (CA7 ant. compared to CA7 post.)
		Dorsiflexion	22.7	18.5	32.6	19.9	++ (CA7 ant. compared to CA7 post.)
		Final plantar flexion	20.0	18.8	24.2	30.8	0

^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

Author's Conclusion (Translation – English)

“In summary, from a biomechanical perspective, both orthotic concepts represent a highly recommended treatment option for the patient group studied. The different concepts enable healthcare providers to better address the individual functional requirements of patients. For patients for whom dynamic movements, such as fast walking, running, or jumping, are a high priority, the conventional, improved principle with posterior positioning of the carbon spring is recommended. For patients, on the other hand, who must walk on slopes or stairs very frequently due to their living or working environment, the novel approach with anterior positioning of the carbon spring is a recommended alternative.” (Schmalz, 2007)

Author's Conclusion (Original – German)

„Zusammenfassend ist festzustellen, dass aus biomechanischer Sicht beide Orthesenkonzepte eine gut zu empfehlende Versorgungsmöglichkeit für die hier untersuchte Patientengruppe darstellen. Durch die unterschiedlichen Konzepte wird es für den Versorgenden möglich, besser auf individuelle funktionelle Anforderungen der Patienten einzugehen. Für Patienten, bei denen dynamische Bewegungsabläufe wie Gehen mit hohen Geschwindigkeiten, Rennen oder Springen von hoher Priorität sind, ist das herkömmliche, hier verbesserte Prinzip mit posteriorer Positionierung der Karbonfeder zu empfehlen. Bei Patienten hingegen, sich bedingt durch das

Wohn- oder Arbeitsumfeld sehr häufig auf Schrägen oder Treppen bewegen müssen, ist der neuartige Ansatz mit anteriorer Positionierung der Karbonfeder eine ratsame Alternative.“ (Schmalz, 2007)

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References

[1] Schmalz, T., Blumentritt, S., Wagner, R., Junge, R.: Biomechanisch-ganganalytische Bewertung verschiedener Behandlungsmethoden nach Ruptur des vorderen Kreuzbandes. [Biomechanical gait analysis evaluation of different treatment methods after anterior cruciate ligament rupture]. Sportverl Sportsch 12 (1998) 4, 131-137.

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