

Biomechanical Principles of Common Orthotic Treatment Concepts for Gait Problems in Cerebral Palsy – A Critical Consideration

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Aims

The major goal of an orthotic treatment in cerebral palsy (CP) is to come closer to a physiological gait. An ankle-foot orthosis (AFO) prepares the foot for initial contact, enables stability and supports the ankle's push-off. It should have a positive effect on therapy, reduce energy consumption and must not lock residual physiological motion.

The Amsterdam Gait Classification evaluates knee position and foot-floor contact in mid stance in order to determine the requirements for an orthotic treatment.

Respecting the gait types of the Amsterdam Gait Classification, a detailed consideration of existing AFO types should indicate whether all requirements for an effective orthotic treatment can be met.



Methods

The effects of common AFOs are evaluated. The basic goals of an orthotic treatment result from the Amsterdam Gait Classification: plantar flexion and foot-floor contact, physiological knee extension and push-off as well as ability to adapt to the gait type. Certain biomechanical features of an orthosis help to achieve these goals.

Considering criteria of adjustable range of motion, defined pivot point, spring force, shell design and adjustable alignment, solid AFO (SAFO), dynamic AFO (DAFO), floor reaction AFO (FRAFO), posterior leaf spring AFO (PLS AFO) and hinged AFO (HAFO) are compared.



Results

	Adjustable Alignment	Adjustable Range of Motion	Plantar Flexion Resistance	Variable Spring Force	High Spring Force	Defined Pivot Point
SAFO	✗ not after manufacturing	✗ not possible	✗ if activities tend to not flex ✓ if activities tend to not flex in SPD	✗ not after manufacturing	✗ not possible	✓
DAFO	✗ not after manufacturing	✗ not possible	✗ high force carbon fiber AFO ✓ polypropylene AFO	✗ not after manufacturing	✗ high force carbon fiber AFO	✗ not possible
FRAFO	✗ not after manufacturing	✗ not possible	✗ not applicable	✗ not possible	✗ not applicable	✗ not applicable
PLS AFO	✗ not adjustable joints (movable)	✗ not adjustable joints (movable)	✗ built-in 90° stop in plantar flexion force ✓ joints with adjustable springforce	✗ not adjustable joints (movable)	✗ telescopic or cast spring points ✓ e.g. the spring points	✓
HAFO	✗ not after manufacturing	✗ not possible	✗ not possible	✗ not after manufacturing	✗ e.g. polypropylene and forged type ✓ carbon fiber, high water and stiff axles	✗ stiff axles type ✓ hinges type HAFO
HAFO	✗ not after manufacturing	✗ not possible	✗ not possible	✗ not after manufacturing	✓	✗ not possible

Discussion

Due to an appropriate orthosis, coming closer to a physiological gait and improving energy consumption of children with CP is possible. Common AFOs do not fulfill all necessary requirements because basic adjustment possibilities are missing (see results). Gait types 3 to 5 of the Amsterdam Gait Classification require high to extra high spring forces in the ankle joint in addition to a ventral shell for achieving physiological knee extension in mid stance. Due to changes in gait the spring forces must be variable.

A passive plantar flexion in loading response depends on adjustable range of motion and a defined pivot point. Resulting eccentric muscle work supports therapy. The correct alignment of the orthosis using biomechanical principles is essential especially when tuning the AFO.

The resulting demand is: Both dynamic and static AFOs should be produced with an adjustable ankle joint.

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Principles Of Orthotic Treatment

Brenda M. Coppard, Helene Lohman



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