Adjusting spring force of ankle foot orthoses according to gait type helps improving joint kinematics and time-distance parameters in patients with hemiplegia following stroke

July 2017 Cerebrovascular Diseases 43(Supplement 1):146-147

DOI: 10.1159/000471872

Project: Apoplexy Guide - A Concept for the Orthotic Treatment of Gait Problems after a Stroke

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Abstract

Question: Patients with hemiplegia following stroke develop pathological gait. Ankle foot orthoses (AFOs) are often prescribed to improve gait and increase mobility. Different biomechanical situations induce either a hyperextended or a hyperflexed knee in mid stance. These gait types are described by the N.A.P.® Gait Classification [1]. Since both gait types have different demands on spring force, we wanted to know how gait can be improved when considering this fact in planning an AFO. Methods: Eight patients (age 52.4, 82 kg, 177 cm) with hemiplegia due to ischaemic stroke were classified into a hyperextension (GT 1, n=5) and a hyperflexion group (GT 2, n=3) according to N.A.P.® Gait Classification. Each patient was fitted with a custom-made dynamic ankle foot orthosis with an adjustable spring hinge joint (DA-AFO). The joint was equipped with very strong ventral spring units controlling dorsiflexion for GT 1 and GT 2. Very strong dorsal spring units controlling plantar flexion were chosen for GT 1 and medium spring units for GT 2. A two-dimensional gait analysis was performed with patients wearing standardised footwear plus DA-AFO and with shoes only. In each condition, three full gait cycles were recorded. Lateral kinematics of hip, knee and ankle as well as maximum joint positions in stance (0-65 % of gait cycle) and time-distance parameters were calculated. A Wilcoxon rank-sum test was used to spot differences between both conditions. Results: The DA-AFO affected joint kinematics compared to shoes-only condition in both gait types (Fig. 1). GT 1 shows a 4° higher, GT 2 a 5° reduced knee angle in stance. When wearing a DA-AFO, maximum dorsiflexion is significantly reduced in GT 2 whereas ankle angle at initial contact is about 15° higher in GT 1. Compared to shoes-only condition, most time-distance parameters significantly increased in both gait types when wearing the DA-AFO (Tab. 1). Conclusions: The DA-AFO's very strong dorsal spring unit helps bringing the tibia forward and supporting knee flexion in GT 1, whereas the medium spring unit enables physiological plantar flexion during loading response in GT 2. Additionally, the very strong ventral spring unit supports an almost physiological knee extension in stance. The ankle kinematics in GT 1 closely follow these changes in the knee joint. This might also be responsible for improvements in time-distance parameters where the increase in stride length and velocity are mostly relevant for both gait types. An effective orthotic intervention should consider the different demands on spring force of stroke patients with hyperextended and hyperflexed knee for improving kinematics and time-distance parameters.

[1] Sabbagh D et al. Orthop Tech 2015. 66(3): 52-57. N.A.P.® is a registered trademark of Renata Horst