

EFFECTS OF AFO-ASSISTED ANKLE ANGLE POSITION ON DYNAMIC KNEE STABILITY IN BRAIN INJURED AND SPINAL CORD INJURED PATIENTS

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INTRODUCTION

In stroke patients and patients with an incomplete spinal cord injury (SCI) normal gait is affected. One of the problems is the lack of ankle control due to either paresis of the ankle dorsiflexors and/or spasticity of the calf muscles, causing either primary toe-strike or, in mild paresis, drop foot. Another phenomenon observed is (often extreme) knee hyperextension in the latter part of the stance phase, often aggravated by weakness of the quadriceps muscles. This knee hyperextension can be viewed as an attempt to stabilise the knee to facilitate push-off. However, next to the kinematic inefficiency, this hyperextension will, over time, cause severe damage to the joint at its ligaments. Whereas it has been shown that the use of an ankle foot orthosis (AFO) does not impair lower leg muscle function [1], the effect of AFO use on knee dynamics has not been investigated systematically. Aim of the present study was to assess the effect of AFO-assisted ankle angle position on knee motion and walking symmetry in patients with unilateral dropfoot or pes equinus due to stroke or incomplete SCI.

METHODS

14 subjects (4 incomplete SCI and 10 stroke patients; m/f=8/6; mean age 48.5 (13.6)) participated. All subjects were able to walk unaided for at least 20 m. Gait was evaluated in three AFO conditions: no-AFO (NA), AFO with an ankle angle of 0° dorsiflexion (AA0), and AFO with an ankle angle of 10° dorsiflexion (AA10). Each patient used a custom-built AFO. A hinge at the ankle level facilitated the use of several (fixed) ankle angles (figure 1).

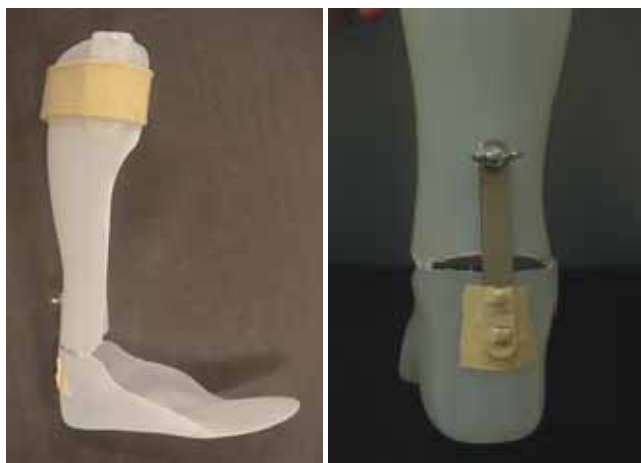


Figure 1: Ankle foot orthosis with variable ankle angle.

Gait timing parameters were recorded using bilateral insole pressure sensors (IDM, RIS GmbH, Berlin, Germany). Sample rate was 50 Hz. Sample time was 1 minute. Bilateral knee joint movement was recorded using 2 biaxial electrogoniometers (Penny & Giles, XM110, Biometrics,

Gwent, UK). Data were recorded at 100 Hz on a portable data logger (Porti-24/ASD, TMS Int., Enschede, NL) (see figure 2).



Figure 2: Equipment used.

Maximum knee extension and knee flexion ratio (FR) between affected and unaffected limb were calculated. Data were analysed off-line using Matlab software (The Math Works Inc., Natick, Mass). Statistical analyses included Friedman two-way analysis by ranks. Post-hoc multiple comparison was performed using Wilcoxon signed ranks tests.

RESULTS AND DISCUSSION

Average maximum knee extension at the affected side was 4.8° larger in condition NA relative to condition AA10 ($p < 0.01$), whereas differences between NA and AA0 (NA: 3.3° more knee extension) as well as between AA0 and AA10 (AA0: 1.7° more knee extension) failed to attain significance levels. As to walking symmetry, ankle angle manipulation did not lead to significant changes in either the FR between AFO conditions or in the stance phase duration between conditions.

CONCLUSIONS

Changing the ankle angle of an AFO may be used in stroke patients and in incomplete SCI patients suffering from either dropfoot or pes equinus to reduce harmful knee hyperextension during gait. Optimal active knee control is present when the knee remains (slightly) flexed. In contrast, gait symmetry seems not to be influenced by manipulation of the AFO ankle angle in these patients. Although other AFO parameters may also influence knee hyperextension during gait, like stiffness of the AFO and heel height, a stiff AFO or a high heel may reduce or even prevent normal rocking of the foot during the stance phase, thus reducing walking ability. This trade-off between different AFO characteristics should always be kept in mind.

REFERENCES

1. Geboers J. et al. *Arch Phys Med Rehabil* **83**,240-245, 2002.