The Effects of Ankle Foot Orthoses and Dorsiflexion Assist Wraps on Gait Kinematics of Healthy Adults

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Introduction

Stroke is a highly prevalent condition in this country, affecting 795,000 people annually and is the number one leading cause of long-term disability.[1] One of the associated gait deviations with stroke is drop foot, or the inability to maintain lower extremity clearance of the ground during the swing phase of gait. Ankle-foot orthoses or AFOs can be used to reduce foot drop in gait and are the most widely used type of orthoses, accounting for 26% of clinical practice by certified orthotists.[2] Current clinical practice guidelines regarding stroke rehab recommend using an AFO for people with foot drop to improve mobility and paretic ankle and knee kinematics, kinetics and energy cost of walking.[3] Dorsiflexion assist ace wraps are another solution to reduce foot drop and are often used in clinical settings to maintain foot clearance during walking trials when an AFO is not available.

Purpose

The purpose of this study is to assess the effects of an AFO and DF wrap on ground reaction forces and kinematics of the hip, knee and ankle on healthy individuals to determine the parameters' effects on post-stroke individuals.

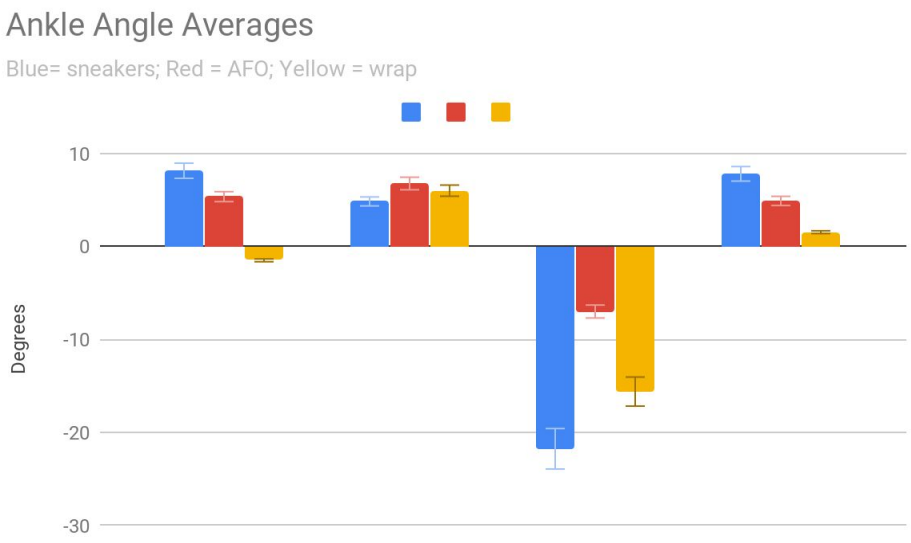
Methods

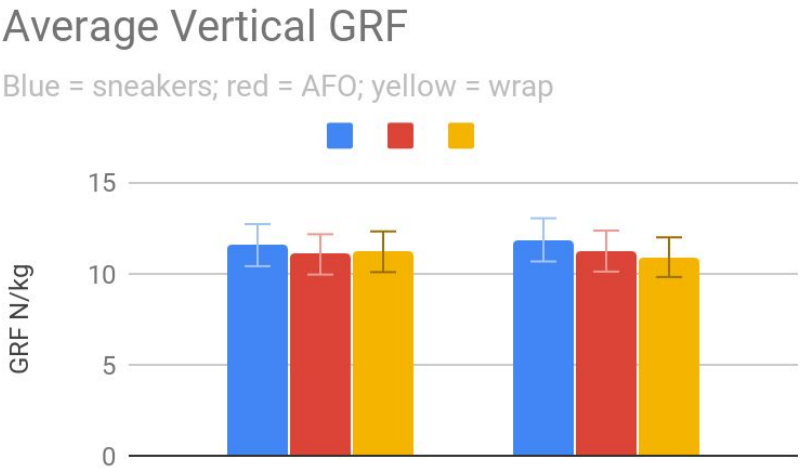
In this study, our subjects were two healthy, able-bodied 23 year-old females. Anthropometric data was gathered such as leg length, knee width and ankle width using a caliper as well as height and body weight, which are then entered into the Vicon motion capture system. Sixteen body markers were placed on each subject's lower extremity. The body markers and force plate provided information on kinematics of the lower extremity and ground reaction forces respectively, Subjects performed three walking trials for each experimental condition to average the kinematic and kinetic data. The subjects walked at their normal walking speed with the AFO/DF wrap applied to the left lower extremity. The independent variables **(**experimental conditions) were use of a Posterior Leaf Spring AFO with shoes, DF ace wrap with shoes, and a control of shoes and no AFO. Our dependent variables were hip, knee, and ankle angles, and AP and Vertical GRF.

Results

At the ankle, we noted greater plantarflexion occurred at initial contact with the DF wrap versus the AFO, which provided a small amount of dorsiflexion at initial contact. At push-off, the least amount of plantarflexion was demonstrated in the AFO compared to the

wrap and sneaker. During mid-swing, the least amount of dorsiflexion occurred with the wrap versus the AFO or sneaker. At the knee, we found decreased knee flexion with the AFO and full knee extension with the DF wrap at initial contact, hyperextension with the DF wrap in midstance, and decreased knee flexion with the DF wrap during pre-swing. At the hip, we found decreased hip flexion with the DF wrap at initial contact, slightly more hip extension with the DF wrap at midstance, and slightly decreased hip flexion during swing phase. Overall, vertical ground reaction forces decreased with the use of a DF wrap and an AFO. Due to the decrease in dorsiflexion at initial contact with the use of a DF wrap and an AFO, the posterior ground reaction forces decreased as well. Similarly, the use of a DF wrap and AFO restricted push-off by limiting plantarflexion which decreased anterior ground reaction forces.





Discussions

Our results at the ankle went against our hypothesis for initial contact due to the fact that there was no dorsiflexion, but in fact, plantarflexion that occured with the wrap versus the AFO. This means that the AFO did a better job of keeping the foot in dorsiflexion versus the DF wrap at initial contact. We believe these results may be due to the fact that the muscles of dorsiflexion became inactive during this phase due to the support the wrap provides, pulling the foot into dorsiflexion and eversion, compared to an AFO that holds the foot in neutral. Our push-off hypothesis was consistent with the literature in that the AFO allowed the least amount of plantarflexion due to the rigid nature and neutral positioning of the foot. Our results at the knee also went against our hypothesis that we would see increased knee flexion in midstance. The knee extension we saw in swing phase may be due to the restriction we placed at the ankle with the DF wrap. Additionally, knee extension at midstance is required to maintain upright position and functional leg length in contact with the ground as a result of increased DF at the ankle. Our results at the hip went against our hypothesis that minimal change would be seen. We had decreased flex at initial contact because the knee is already in extension so less hip flexion is needed to take the same step length. Our results pertaining to the decrease in ground reaction forces are in accordance to our hypothesis since we predicted the use of an AFO or DF wrap would limit the ankle range of motion therefore decreasing the force produced.

Conclusions

To summarize the kinematic changes we saw, we found that restricting the ankle into a more neutral position brought the knee closer to extension throughout the gait cycle including less flexion in swing phase and increased extension in stance, this resulted in increasing hip extension in stance as well and decreasing hip flexion in swing and IC because the knee is already fully extended

Clinical Implications

The dorsiflexion wrap was still able to produce kinematic changes in gait, and may be a less expensive and more accessible temporary option for gait training. However, decreased dorsiflexion muscle activation was noted with the wrap versus the AFO and may not be the best choice to target strengthening of the dorsiflexors during gait if that is the goal of treatment. Because the AFO's in this trial were not customized, it is possible that our AFO results did not accurately reflect what a well-fitting, customized AFO can do in terms of changes in gait kinematics. We recommend providing patients with properly-fitting, customized AFOs when possible to provide the most benefit.

References

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3.) Winstein CJ, Stein J, Arena R, et al. Guidelines for adult stroke rehabilitation and recovery. *Stroke..* 2016; 47: e98-e169.