Plantarflexion Resistance of Selected Ankle-Foot Orthoses: A Pilot Study of Commonly Prescribed Prefabricated and Custom Molded Alternatives

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INTRODUCTION
Ankle-Foot-Orthoses [AFOs] are one of the most commonly prescribed lower limb orthoses. Despite their widespread clinical application, only a limited amount of objective data has been published regarding the control offered by specific AFO designs. This study was conducted to objectively document the resistance to plantarflexion of a variety of commonly prescribed AFOs. This data may prove useful in verifying the effectiveness of such orthoses when used to facilitate ambulation for individuals with neuromuscular impairments, and in developing prescription criteria for their clinical application. Previous authors have shown that the sagittal plane stiffness of the tested AFO’s varies widely (Yamamoto 1993 et.al. and Golay et.al.1989) and that resistance provided significantly affects gait (Yamamoto 1993 et.al.).

METHOD
A volunteer subject was recruited who is a normal 59-year-old male 6’3” tall and weighing 245 pounds. A negative impression was taken of his right lower leg in the conventional manner. His foot was placed in a neutral position on a casting plate to simulate the foot bed of a conventional shoe with a 12-mm (half inch) heel rise. The final model, which may be considered representative of a typical large adult male lower leg, was then duplicated in rigid polyurethane foam over a plywood core and reinforced externally with a lamination over a single layer of nylon stockinet. The laminated model was then used to create the test apparatus, which was similar to that described by (Golay et al 1989).

RESULTS
The tested orthoses fell into three distinct groupings based on the average static resistance to plantarflexion. The first grouping can be termed the “plantarflexion stop” or PFS orthoses as they all provided at least 20 pounds of resistance when set initially in a neutral position. When adjusted to an initial alignment in 10 degrees of dorsiflexion, this group all provided at least 45 pounds of resistance in the measured position. Clinical observation has confirmed that these devices significantly limit plantarflexion motion and their use is recommended only when such a reduction in the range of motion at the ankle is desired. The second grouping of orthoses provided 10-16 pounds of resistance in neutral and 20-25 pounds of resistance from an initial angle of 10 degrees dorsiflexion. This group had effective dampening of plantarflexion during loading response and appropriate resistance to plantarflexion to provide necessary toe clearance in swing phase. This grouping could be termed the “plantarflexion resistance” or PFR orthoses. The third group provided no more than five pounds of resistance from a neutral position and included all the tested prefabricated recumbent splints. This group may be termed the “non-ambulatory” or NA devices since clinical experience has shown that such minimal resistances are insufficient to assure toe clearance or to significantly decelerate the foot in early stance.

DISCUSSION
It should be noted that this study looked only at one aspect of AFO function: resistance to movement toward plantarflexion.

CONCLUSION
This study found that commonly prescribed contemporary AFO designs could be grouped according to the maximum static resistance provided when deflected to 10 degrees of plantarflexion. The designs that would stop plantarflexion movement all provided the greatest magnitude of measured resistance and were predominantly custom made orthoses. The group that provided intermediate levels of resistance but also allowed a significant range of ankle motion included custom made orthoses and all except the heavy-duty PRAFO® designs. The group that provided only minimal resistance was all non-adjustable prefabricated splints best suited for non-ambulatory applications.

CLINICAL APPLICATIONS
Prescribing physicians, orthotic clinicians, and reimbursement authorities may be able to use such objective data to help distinguish between orthoses that are superficially similar in appearance but offer distinctly different biomechanical advantages.

REFERENCES
Yamamoto, S et.al. J Prosthet Orthot 1, 59-64, 1993
Golay W et.al. J Prosthet Orthot 1, 231-242, 1989

American Academy of Orthotists & Prosthetists
39th Academy Annual Meeting and Scientific Symposium
February 20-23, 2013