Footwear Science
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/tfws20

Balance improvement in older adults using customised ankle foot orthoses

Sai Vikas Yalla [a] , Jacque Ortiz [a] , Ryan T. Crews [a] & Bijan Najafi [b]
[a] Rosalind Franklin University of Medicine & Science, CLEAR, North Chicago , United States
[b] University of Arizona, College of Medicine, Surgery, interdisciplinary Consortium on Advanced Motion Performance (iCAMP) , PO Box 245072, 1501 N Campbell Avenue, R 7342, Tucson , 85724-5072 , United States
Published online: 09 Jul 2013.

To cite this article: Sai Vikas Yalla , Jacque Ortiz , Ryan T. Crews & Bijan Najafi (2013) Balance improvement in older adults using customised ankle foot orthoses, Footwear Science, 5:sup1, S119-S120, DOI: 10.1080/19424280.2013.799593

To link to this article: http://dx.doi.org/10.1080/19424280.2013.799593

Balance improvement in older adults using customised ankle foot orthoses

Sai Vikas Yalla[a*], Jacque Ortiz[a], Ryan T. Crews[a] and Bijan Najafi[b]

[a]*Rosalind Franklin University of Medicine & Science, CLEAR, North Chicago, United States;* [b]*University of Arizona, College of Medicine, Surgery, interdisciplinary Consortium on Advanced Motion Performance (iCAMP), PO Box 245072, 1501 N Campbell Avenue, R 7342, Tucson, 85724-5072 United States*

(*Received 25 February 2013; final version received 16 April 2013*)

Introduction

Falls are a major health concern for the rapidly growing elderly population. Estimates of the proportion of elderly that fall each year have ranged from 22.1% to almost 40% (Hausdorff *et al*. 2001, Shumway-Cook *et al*. 2009). There is a large volume of studies that have shown the benefits of ankle foot orthoses (AFO's) for individuals that have suffered a stroke or non-progressive brain lesions (Tyson and Kent 2009). AFO's have also been shown to reduce a number of fall risk factors through improving gait and balance in these populations, however research involving a less restrictive sample of the elderly population is lacking.

Purpose of the study

The aim of this study was to determine whether a customised AFO could reduce fall risk in ambulatory elderly individuals.

Methods

Subjects aged 65 years or older who were able to walk unassisted for 20 metres were recruited. Individuals with hemiplegia or excessive lymphedema were excluded from the study. During the initial visit subject demographics and shoe size were collected and castings for the customised AFO were performed. The AFO used in the current project were with open dorsal ankle design with customised footplate and arch support as shown in Figure 1.

At the second visit, balance assessments were performed using a system of body worn sensors (BalanSens^{TM}, Biosensics LLC). The method of estimation and validation has been described in detail in Najafi *et al.* (2010a, 2010b). Balance was assessed during eyes-open and eyes-closed under three footwear conditions: barefoot, with standardised shoes, and with standardised shoes and bilateral AFO.

In addition to balance test, a functional reach (FR) task (Duncan *et al.* 1990) and timed up and go (TUG) test were performed by the subjects while wearing the standardised shoes with and without AFO's. A fall efficacy scale (FES-I) questionnaire was also administered to assess the concern level of fear of falling.

Results

Fifteen subjects (3 male, 12 female) were recruited whose average age was 73(8.0) years. Body mass index (BMI) ranged from 22 to 37.2. FES-I scores averaged at 30.6 (7.87) demonstrating the participants to be ranging from low fear of falling to moderate concern for falls. During eyes open balance assessments, use of AFO with shoes reduced the COM sway significantly ($p < 0.05$, Figure 2) by 68% and 75% when compared to shoes and barefoot respectively. Similar significant drops of 53% and 61% were observed when compared to shoes and barefoot

Figure 1. AFO with customised arch support, footplate and adjustable straps.

*Corresponding author. Email: sai.yalla@rosalindfranklin.edu

http://dx.doi.org/10.1080/19424280.2013.799593

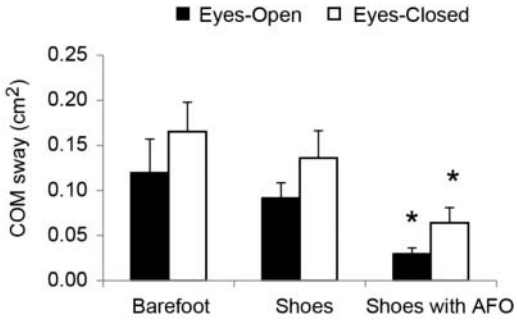

Figure 2. Centre of mass sway was significantly improved after wearing customised AFO.

during the eyes closed Romberg's test with customised AFO's.

No significant differences of functional reach distance were observed between the barefoot, shoes and shoes with AFO's conditions. However, an 18% significant drop of reciprocal compensatory index (Najafi *et al*. 2010a) values in the media-lateral direction was observed while using AFO's when compared to both barefoot and standard shoes conditions. This indicates that although the AFO's provide good postural stability, they did not restrict the reach distance. No significant differences were observed in the time required to complete the TUG test suggesting AFO's do not influence the time taken for normal activities. TUG results were 14.6(4.1) sec with standard shoes and 15.3 (4.7) sec with AFO's in standard shoes suggesting mobility is not hindered with the use of AFO's.

Discussion and conclusion

The results of this study indicate the use of an AFO provides an immediate reduction of fall risk in the elderly, without encumbering functional reach or gait. Additional studies are required to determine if the reduced fall risk actually translates into fewer falls.

References

Duncan, P.W. *et al.* (1990). *J Gerontol* 45(6), M192–M197.
Hausdorff, J. *et al.* (2001). *Arch Phys Med Rehabil* 82(8), 1050–1056.
Najafi, B. *et al.* (2010a). *J Diabetes Sci Technol* 4(4), 780–791.
Najafi, B. *et al.* (2010b). *Diabetes Care* 33(11), 2448–2450.
Shumway-Cook, A. *et al.* (2009). *Phys Ther* 89(4), 324–332.
Tyson, S.F. and Kent, R.M. (2009). *Cochrane Database Syst Rev* 1, CD003694.

Homologous shape modelling of deforming human foot

Shuntaro Yamazaki[a]*, Makiko Kouchi[a], Masaaki Mochimaru[a], Shunta Saito[b], Yuji Yoshida[b] and Yoshimitsu Aoki[b]

[a]*AIST, DHRC, Tokyo, Japan;* [b]*Keio University, Tokyo, Japan*

(*Received 25 February 2013; final version received 16 April 2013*)

Introduction

Recent advances in scanning technologies allow us to obtain the high-resolution 3D surface model of dynamic feet (Kimura *et al*. 2009, Schmeltzpfenning *et al.* 2009). The scan data, however, are merely a set of 3D coordinates, and do not deliver any anatomical information. Recovering anthropometric data from the scan data is essential to utilise the 4D scanning technologies in such fields as biomechanical analysis, anthropological research, and industrial product design. In this research, we have developed a system for homologous modelling of a human foot in motion. A template mesh model is registered to each of the scan data, yielding the homologous model that best approximates the object shape. While various techniques of homologous modelling have been proposed mainly for static shapes, our algorithm has achieved considerable robustness to large deformation by taking advantage of the temporal smoothness of the scan data.

Methods

The modelling process consists of two steps. In the first step, a template foot model is constructed for each subject. The model is regular, and has known mesh topology, sparse skeletal structure, and anatomical landmarks. A generic foot model is registered to the scan data in a neutral standing posture using landmark positions extracted manually by experienced anthropologists as hard constraints. In the second step, the template model is registered to the scan data by non-rigid deformation without predefined correspondence. To accomplish the above-mentioned steps, we developed an algorithm of non-rigid mesh registration. The non-rigid deformation is approximated by the combination of local rigid deformation (Sorkine and Alexa 2007). The correspondence between the template model and the scan data is determined by local proximity heuristics and iterative refinement (Li *et al*. 2008). In order to accomplish robust registration

*Corresponding author. Email: shun-yamazaki@aist.go.jp

http://dx.doi.org/10.1080/19424280.2013.799594