



Elevated Vacuum Socket Suspension Improves Balance and Gait Performance in Elderly Dysvascular Transtibial Amputees

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INTRODUCTION

Lower-extremity amputation leads to physical and functional deficits, most frequently with impairments in balance, gait and transfers (1). These deficits will vary depending on the patient's age, comorbidities, level of amputation and level of motivation. Several studies have demonstrated the positive impact of prosthetic devices on these functional deficits (2, 3). However, the percentage of successful prosthesis fitting in geriatric dysvascular patients is low. Fletcher et al. (1) reported that only 36% of amputated geriatric patients receive an adequate prosthesis, with the highest percentage in amputees at the tibial level (64%) and the lowest in patients amputated at the femoral level (31%). Poor linkage between the residual limb and the prosthetic socket is an issue that frequently compromises the ability of the patient to develop confidence and walk safely with the prosthesis, especially in elderly transtibial amputees. Therefore, the purpose of this study was to investigate whether a vacuum assisted socket suspension system improves the control of the prosthetic limb, stability, balance, and walking capabilities in elderly transtibial amputees.

METHOD

A convenience sample of 10 dysvascular transtibial amputees meeting the following inclusion criteria was enrolled to this study: age 50 years or older, unilateral transtibial amputation, prosthesis use for at least 6 months, ability to walk indoors, informed consent to participate. Patients underwent the four square step test (FSST), balance testing using the Berg balance scale, the timed up and go test (TUG), the 6 minute walk test (6MWT) with measurement of the Physiological Cost Index (PCI) and answered the Locomotor Capabilities Index (LCI-5) at baseline with their existing prosthesis as well as after four weeks of use of the VASS Harmony system (Otto Bock HealthCare, Duderstadt/Germany). Statistical analysis was conducted using the Wilcoxon signed rank test with $p<.05$ and a power of 80%.

RESULTS

10 dysvascular TT amputees (8 males, 2 females) with an average age of 63.9 ± 12.1 years, 6 patients MFCL-2, 4 patients MFCL-3, were enrolled and completed this study. As compared to their existing regular sockets patients highly significantly improved their balance as measured on the Berg Balance Scale

from 45.1 ± 7.8 to 49.7 ± 5.9 ($p=.01$) and significantly in the FSST from 18.0 ± 4.2 sec to 15.0 ± 4.4 sec ($p=.02$) when using the VASS Harmony. Average time to complete the TUG highly significantly improved from 14.1 ± 3.2 sec to 11.2 ± 2.8 sec ($p=.01$). In the 6MWT, mean walking distance significantly improved from 304 ± 67 m to 358 ± 38 m ($p=.02$) and average gait speed from 0.84 ± 0.19 m/s to 0.99 ± 0.11 m/s ($p=.02$). There was a trend towards improvement of energy efficiency with a 27% reduction of the mean Physiological Cost Index (PCI) from 0.63 ± 0.25 to 0.46 ± 0.13 ($p=.09$, n.s.) which was not statistically but may be considered clinically significant. The difference in walking capabilities as measured with the LCI-5 was not significant. A trend could be seen that patients with excessive soft tissue at the distal end of the residual limb may benefit more from using the Harmony VASS than patients with a firm residual limb.

DISCUSSION

The results of this study suggest that the Harmony System supports the control of the prosthesis which in turn results in improved balance and walking performance of elderly dysvascular transtibial amputees, especially those with excessive distal soft tissue. To our knowledge no comparable study has been published so far. The likely reason for the improvements seen may be the improved linkage between the residual limb and the prosthetic socket that minimizes relative movements and pistoning between the residual limb and the prosthetic socket (4, 5), thus improving the patient's perception (often wrongly referred to as "proprioception") and motor control of the prosthesis.

CONCLUSION

This study has demonstrated that elevated vacuum socket suspension as created by the VASS Harmony device may improve balance and walking performance in elderly TT amputees as compared to regular prosthetic sockets.

REFERENCES

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