PRELIMINARY ANALYSIS OF AN ELEVATED VACUUM SUSPENSION SYSTEM WITH MICROPROCESSOR CONTROLLED VACUUM LEVELS

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INTRODUCTION:

Elevated vacuum suspension systems have been reported to improve limb volume control and reduce pistoning of the limb in the socket relative to the non-vacuum condition (Board, 2001). The improvement in socket fit reduces the likelihood of skin ulceration, skin irritation, discomfort, and pain.

In order to amplify the benefits of vacuum suspension technology, prosthetic users have voiced that an adaptable suspension system that adjusts to activity is needed (Klute, 2009). Therefore, a novel elevated vacuum suspension system was designed to intelligently determine what activity is taking place and automatically adjust the pressure levels accordingly (Edison™, Orthocare Innovations). In addition, it features a quick vacuum release mode to enhance socket comfort during inactivity. The design also lends itself to virtually noiseless operation. This study presents preliminary data on this vacuum suspension system with microprocessor controlled vacuum levels.

METHOD:

A research subject was tested while sitting and walking on a treadmill to determine the vacuum levels reached and how the vacuum pump behaved. The subject wore an endo-skeletal transtibial prosthesis with an OttoBock polyurethane liner and a WillowWood Alpha flex sealing sleeve. A 15 psi vacuum gage (Honeywell Sensing and Control) was used to record the pressure within the socket.

A second research subject with an endo-skeletal transtibial prosthesis, WillowWood liner and OttoBock sealing sleeve, wore the system for two weeks and filled out a survey regarding its convenience, socket limb security, system noise, limb volume changes, and perceived change in feel/function of limb. Additional data collection is underway.

Data Analysis: The accuracy of the system to identify and respond to a change in activity was compared to the actual observed activity (i.e. sitting, walking, etc). Highlights of the survey results are also reported.

RESULTS:

The system accurately detected and responded to changes in activity level. Figure 1 shows the pressure profile for a sample of activity tested. The survey results in Table 1 indicate a preliminary positive response. Open-ended responses included a comment on increased perspiration on warm days.

DISCUSSION:

Initial results indicate that the vacuum pump is giving enhanced security and limb volume stability over the subject’s conventional suspension system, while operating quietly. The subject’s comment on an increase in perspiration was likely due to environmental temperature increases at the time of testing. The subject also noted that they felt very secure and confident while using the system.

CONCLUSION:

Microprocessor controlled vacuum pressure based on user’s activity may enhance the user’s experience with an elevated vacuum suspension system. Ongoing data collection will help determine the validity of this preliminary result.

REFERENCES

Board, W. J. Prosthet Orthot Int 25, 202-209, 2001
Klute, G. K. JRRD 46, 293-304, 2009