INTRODUCTION

Individuals with transfemoral (TF) amputation or knee disarticulation (KD) may benefit from vacuum assisted suspension (VAS). Preliminary research suggests VAS may improve stability, weight bearing, comfort, proprioception, limb health and function. In order for VAS to work, a pump creates an environment of negative pressure that is coupled with other components to create an airtight seal to secure the socket onto the residual limb. Clinically, there is question as to how high the superior socket brim needs to be to maintain suspension and stability. Biomechanically it is known that if the brim height is subischial (SI) then the pelvis and hip can be more disassociated and provide improved lower extremity mechanics. This experiment investigated the role brim height has on balance and gait.

METHOD

Subjects: This preliminary report includes 5 (3 male) individuals with unilateral lower limb amputation [4 TF, 1 KD, mean age 53.6 (35-68)]. Average time since amputation was 13.8 years (4-24). Three subjects were classified as MCFL-4 and two MCFL-3. We expect to enroll 10 upon completion of the study.

Procedures: At session 1, subjects were measured for a VAS single-walled ischial containment (IC) socket using the Harmony system (Otto Bock) in combination with the Evolution Aura Sheath. At session 2, the VAS socket was fit and aligned on the subject’s existing prosthesis (knee unit and distal) using the LASAR alignment tool. The VAS socket was then removed. At session 3, subjects underwent instrumented gait analysis using the Vicon Motion Analysis and a limits of stability (LOS) test with the Biodex Biosway. Testing occurred under 4 conditions:

Control: Existing prosthesis
High: New VAS socket affixed to existing prosthesis; brim at IC level
Mid: VAS socket brim trimmed to 25% SI
Low: VAS socket brim trimmed to 50% SI

Data Analysis: The mean % change in LOS from control was calculated in the forward, backward, toward and away from prosthetic directions (Fig1). Mean gait variables and maximal knee flexion and hip extension angles are reported. Balance data includes mean of 4 subjects and gait data mean of 2 subjects for the low level. All subjects reported the low level presented stability difficulties, and four stated that they had tried VAS they are inclined to pursue this technology in future socket builds.

RESULTS

The mean SI brim height at mid and low was 75.6 and 151.2mm respectively. Reducing the brim may alter directional control during LOS testing and may alter gait, particularly at the mid height with improvements noted in non-prosthetic limb (NPL) step and stride length and prosthetic limb (PL) maximal hip extension.

DISCUSSION

Reducing brim height to SI, (mid and low level) may improve directional control as measured through LOS. Further, at the mid level, PL hip extension along with NPL step length appear to increase. We hypothesize these changes may have occurred because the femur has less restriction relative to the pelvis. While it appears that the low is too low, maximum suspension and maintenance of a sub-atmospheric environment was achieved in all cases. However, only one subject reported they would try the low brim level despite the reduced stability felt. Continued investigation will focus on determining appropriate SI brim height and user characteristics, such as limb consistency, to ascertain whom reduced brim height in combination with VAS is most appropriate for.

CONCLUSION

Preliminary evidence suggests using VAS with a brim 25% SI may improve function when compared to an individual’s existing, IC non-VAS prosthesis.

REFERENCES