A PRELIMINARY STUDY OF THE EFFECTS OF GEL LINER THICKNESS ON IN-SOCKET RESIDUAL LIMB PRESSURES IN TRANS-TIBIAL PROSTHESIS USERS
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Introduction:
Polliack et al. (2000) pointed out that measuring pressure at the interface between the residual limb and the prosthetic socket could provide valuable information about the process of socket fabrication, modification, and fit. Two studies (Seelen et al., 2003 and Dou et al., 2006) investigated pressure distribution at the residual limb/socket interface using 6mm gel liners. Dou examined pressure during walking on stairs and slopes rather than level walking. Seelen studied the effects of prosthesis alignment on pressure distribution. The purpose of this preliminary study is to examine the effects of gel liner thickness (3mm and 9mm) on residual limb pressures.

Methods:
Subjects: Four subjects (3 men, 1 woman) with unilateral trans-tibial amputations due to trauma. Mean (± standard deviation) age was 51.8 ± 10.5 years, mean weight 88.5 ± 14.4 kg, and mean height was 174.5 ± 9.3 cm. Mean time since amputation was 7.5 ± 5.4 years.

Prosthetic Components: Alpha Liners (3mm and 9mm) from Ohio Willow Wood (Mt. Sterling, OH) were used in this study. Sockets for both gel liners were made for each subject using a CAM system developed in our laboratory called Squirt Shape (Rolock and Tucker, 2001). An Otto Bock (Duderstadt, Germany) 1D35 prosthetic foot was fitted onto each prosthetic leg for each subject. A certified prosthetist performed all fittings and alignments.

Protocol: Subjects adapted to each prosthetic leg for a minimum of two weeks prior to testing. A gait analysis was performed with the person walking at his normal self-selected speed for each gel liner condition. Mean walking speed across all subjects and conditions was 1.22 ± 0.12 m/sec. Prior to each gait evaluation, 6cm x 3cm pressure sensors (Pliance, Novel Electronics, Inc.) were placed over the patellar tendon region, the fibular head, and the anterior distal tibia (Figure 1). Pressure data were synchronized with the motion data (Figure 2) to allow for calculations of the gait events (OrthoTrak software, Motion Analysis Corporation, Santa Rosa, CA). All pressure data were recorded at 120 Hz.

Results:
Mean maximum pressures for each sensor matrix were averaged over multiple gait cycles (Figure 3). Pressure over the patellar tendon region was either reduced with the 9mm liner or did not exhibit a change. Pressure over the anterior distal tibia region did not change appreciably between the 3mm and the 9mm liner. Pressure over the fibular head was reduced in all subjects using the 9mm liner.

Conclusions:
The liner thickness affected pressures at some locations on the residual limb but not all locations. This study is currently ongoing with additional subjects.

References:
Seelen et al., Clinical Rehabilitation 17:787-796 (2003).
Rolock and Tucker, 10th World Congress of ISPO, Glasgow, UK (2001).

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