IMPROVED SOCKET PERFORMANCE AND FIT FOR TRANSFEMORAL AMPUTEES

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INTRODUCTION

Persons with transfemoral and transfemoral amputation experience changes in the fit of their socket over time. These changes arise from changes in the volume of the residual limb that result from weight gain and loss, muscle atrophy, and extra-vascular fluid movement through the lymphatic system. Residual limb volume changes have been well documented with large changes in volume being observed over the course of the day and even shorter periods of time. For example it was demonstrated that residual limb volumes can change by as much as 11.3% after a half-hour of walking1. It was also found that limb volume changes over the course of six months were significantly larger than changes the group observed over the course of the day. Substantial changes in limb volume can lead to a poor socket fit, which was reported to be the primary prosthetic-related concern of persons with transfemoral amputation2,3. In addition, poor socket fit has been shown to cause skin breakdown and gait instability3.

The adjustable socket has two distinct goals: to accommodate for volume change in the residual limb and increase function during gait. For the proposed study, gait and sway parameters will be measured to allow an evaluation as to whether the new socket design can provide a more efficient and less variable gait pattern.

METHODS

• Data from nine transfemoral amputee subjects were collected for this study. An adjustable socket was custom fabricated for each subject and allowed for a percentage of volume increase (Table 1). All procedures were IRB approved and subjects provided informed consent prior to testing.

• Three-dimensional kinematic and kinetic data of the trunk, pelvis and lower extremities during walking was collected for each subject in three conditions: 1) their own socket, 2) the fitted adjustable socket, and 3) the loose adjustable socket (Figure 1). Subjects were required to doff their prosthetic between conditions for a period of 20 minutes to allow the residual limb to return to a steady state volume.

• sway parameters were determined with eyes opened, eyes closed and in a tandem stance.

RESULTS

• Significant results were found more proximally at the pelvis and trunk (Figure 2 and 3). Increased rotational range of motion (ROM) demonstrated compared to typical walking (the grey band) is noted in almost every subject. This increased ROM tends to occur in all conditions. It is very characteristic of above knee amputee gait patterns. This motion helps with propulsion of the I.E. and compensates for the lack of hip, knee and ankle power on the prosthetic side.

• Sway parameters were used to characterize balance during quiet standing using traditional subphase analyses (Figure 4). An ANOVA was performed to determine differences across conditions (own, SL, AS) in the four postural sway parameters. No significant differences could be attributed to the socket type. However, there were differences in several variables between

DISCUSSION

Few gait or balance parameters showed a significant difference between socket conditions. Differences were found between several measured kinematic and kinetic parameters and normal gait values. Varniances tended to be significantly larger at the trunk pelvis and hip perhaps indicating an inconsistent dependence on the upper body during gait. There are several reasons we these results may have been achieved.

First, subjects may not have been given enough time to accommodate to their new sockets. Any discomfort could have caused the subjects to walk in an abnormal pattern. Second, the differences in socket volume may have confounded the results. We attempted to evaluate the effect of percent available increase in socket volume by correlating this value with the calculated RMS values for the gait parameters. The results appear promising but more data is needed to be more conclusive. Lastly, the small number of subjects may not have given us enough power to sufficiently detect small differences in the gait and sway parameters between conditions.

REFERENCES


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