TIMING ASSESSMENT OF TRANSTIBIAL AMPUTEE PROLONGED-GAIT USING IPECS™

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INTRODUCTION

The large and continuously increasing number of low limb amputees underlines nowadays more than ever the importance of gait characterization as a tool for the evaluation of prosthetic devices and enhancement of patient comfort. Pylon force transducers can be used for the solution of this problem as the recent reduction of their size and weight and their enhancement with wireless transmission capabilities promise precise and continuous measurements with minimum influence to the subject’s gait. In this study a new method of prosthesis evaluation is presented based on step durations and stance phase percentage of prolonged transtibial amputee gait measured with a prosthetic wireless gait assessment device-iPecs™ (CPI, 2011). Using this method Total Surface Bearing (TSB) and Elevated Vacuum (EV) socket technologies are compared and the effects of these different socket interventions on prosthesis kinetics are evaluated.

METHOD

Subjects: One bilateral and six unilateral transtibial amputees participated in this study (Age: 65±16 years, body mass: 86±20 kg, body height: 176±7 cm, stump length: 15±4 cm).

Apparatus: All patients were fitted with both a TSB and an EV system and with the iPecs™ device, a fully integrated wireless load cell.

Procedures: All patients were asked to perform at their self-selected speed the Amputee Strenuous Activity (ASA) protocol which covers the most important tasks a person encounters in everyday life (Papaioannou et al. 2011). This study focuses on the walking parts of this protocol.

Data Analysis: All measurements were based on the Antero-Posterior Force which has the greater consistency between steps and its form allows the algorithmic detection of heel-strike and tow-off events. Linear least squares method was used for the regression of all measurements. For the statistical analysis the hypothesis of same measurements was tested at a level of significance p=0.05, assuming a normal distribution for the difference of mean values and slopes of regression lines and an F-distribution for the fraction of variances.

RESULTS

Most subjects walked significantly slower with EV but with lower variability, indicating that patients retrieved a part of their ability to maintain a steady gait. It is worth noting that for the majority of patients the slope of the regression line is negative when using the TSB prosthesis. It seems that patients tend to walk faster with time, a phenomenon that is maybe a result of accumulating discomfort due to the TSB socket fit. On the other hand EV reverses this phenomenon; five cases show statistically significant increase of the slope causing only two to remain negative.

The mean value of stance phase percentage seems to change significantly for six cases. The results can be divided into two groups. In four of these cases the mean value increases and for the rest it decreases, we can therefore conclude that this change depends on the patient. The standard deviation of stance phase decreases significantly for five cases and for one patient the exact opposite occurs.

DISCUSSION & CONCLUSIONS

In this study we attempted to define a new method of prosthesis evaluation based on the characterization of amputee gait. The results indicate that the kinematics behavior of patients differs for the cases of TSB and EV prosthesis. Based on patient commends for the two sockets and our preliminary results it can be stated the EV enhances amputee gait by reducing its variability. Furthermore the tendency of patients to walk faster with time when using the TSB can possibly be a reflex to cope with the accumulated discomfort. All these results can be further examined to minimize the possibility that fatigue (ASA lasts 2 hours) has an influence on the results. Our future work should include the implementation of a device that measures some characteristics of the healthy limb of the patient so as to be able to examine and the symmetry of gait.

REFERENCES

College Park Industries, 2011.

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