The effect of the medial/lateral socket dimension on the prosthetic moments of a trans-tibial amputee

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INTRODUCTION

The internal medial lateral dimension (ML) of the trans-tibial socket plays a critical role in maintaining the coronal plane stability of the prosthesis in single leg stance. The standard of clinical practice is to allow the ML of the socket to be 1/8 inch greater than the ML of the patient's limb.[1] If the socket ML is too loose, when the patient enters single leg stance, the limb will shift in the socket until it comes in contact with one of the walls, typically the medial. This can place excessive pressure on the distal lateral aspect of the limb and make it difficult for the patient to maintain balance. While this is regarded as a clinically established fact, little research exists that quantitatively describes the impact that altering this dimension has on the function of the trans-tibial prosthesis. The purpose of this study was to quantify the change in prosthetic moments that resulted from systematically altering the ML dimension of a trans-tibial socket.

METHOD

A single male subject was recruited to participate in this study. (Age: 64 Weight:105 kg Height:72 inches, Years since amputation: 43). The subject is an established K3 level ambulatory who rated his socket comfort as 10 of 10. The subject uses a total surface bearing socket with VASS suspension and an Endolite Echelon foot. A duplicate of his socket was fabricated with a series of 1/8" thick removable wedges at the medial condyle. An Orthocare Innovations Smart Pyramid was mounted at the distal aspect of the duplicate study socket to record sagittal and coronal plane moments in the prosthesis during gait. The subject's comfortable and optimal prosthetic alignment was established on the study socket prior to data collection. Moment data and socket comfort scores were collected for each of the following conditions: Baseline, ML 1/8" greater, and ML ¼" greater. Data was collected in a single test session and the subject was allowed to rest as needed. Moment data for each of 15 steps was normalized to 100% of stance phase for analysis. A Pearson Correlation Coefficient (PCC) was calculated to test the differences between conditions.

RESULTS

The patient reported a decrease in socket comfort score as each subsequent wedge was removed; Baseline: 10/10; 1/8" over: 9/10; ¼" over: 8/10. The subject showed very little change in the sagittal moment profile during stance phase. The mean coronal plane moment did not differ substantially, but as the ML dimension increased the variability of the coronal plane moment profile increased significantly. (PCC: baseline vs. 1/8" = -0.23; baseline vs. ¼" = -0.43) Figure 1 shows the time series for the standard deviation for the coronal plane moment in the baseline, 1/8" over, and ¼" over conditions.

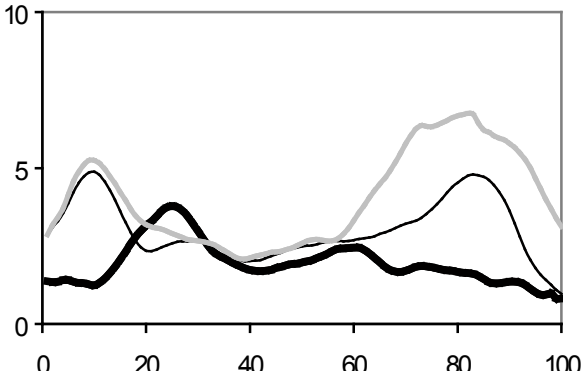

Figure 1. Standard deviation of the coronal plane moment (Nm) for 15 steps in the baseline (heavy black), 1/8" over (thin black) and ¼" over (heavy grey) conditions. Data is normalized to 100% of stance phase.

DISCUSSION

This case study characterizes the impact of an excessively loose ML dimension on the prosthetic moments of an established walker. He was able to control the prosthesis in a way that made it difficult to observe gait differences between the test conditions. Increasing the ML dimension did not result in large changes to the average moment profile, but did produce significant between-step variability. The subject's attempts to deliberately control an unstable socket may explain these results.

CONCLUSION

For an established walker, between-step variability of the moment profile may be an important clinical determinant of socket stability.

REFERENCES

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