Joint moments during downhill and uphill walking of a person with trans-femoral amputation with a hydraulic articulating and a rigid prosthetic ankle - a case study

Authors: N. Alexander[1], G. Strutzenberger[1], J. Kröll[1], C.Barnett[2], H. Schwameder[1]

[1]Department of Sport Science and Kinesiology, University of Salzburg, Austria

[2]School of Science and Technology, Nottingham Trent University, Nottingham, UK.

Published in: Journal of Prosthetics and Orthotics (JPO) 2018; 30(1): 46-54.

Summary

This gait analysis study sought to investigate the effects of a microprocessor-controlled hydraulic ankle compared to a fixed ankle design when walking at a range of graded inclines, ranging from -12 to +12 degrees.

Method

Components: Dynamic response style foot (Esprit, "RIGID") and a microprocessor-controlled, articulating hydraulic ankle (Elan "ARTIC"). The subject used a microprocessor-controlled knee (Orion) throughout.

Measurements: 3D gait analysis with 12 cameras (Vicon) and ground reaction forces from two force plates (AMTI) built into a hydraulically adjustable ramp walkway.

Subjects: A single unilateral trans-femoral amputee (male; 44 years; 85kg; 1.84m; traumatic aetiology; 29 years previous). Able-bodied control group (n=18; all male; 27±5years; 75±8kg; 1.80±0.05m).

Data collection protocol: Randomised crossover testing of each foot. The subject walked at a self-selected speed on a ramp at five different gradients: -12°, -4°, 0°, 4° and 12°. He performed five trials on each gradient, for each prosthetic condition. No data existed at 4º gradient for the able-bodied group so between-group comparisons were limited to level-ground walking and gradients at ±12º.

Analysis: Measurements were time-normalised over stance phase and normalised to body mass. The mean value was calculated for each outcome measure over the five trials.

Results

The changes in gradient effected joint kinetics similarly in the amputee participant and the able-bodied control group. The prosthetic ankle-foot condition had the greatest influence at the residual hip. Compared to the "RIGID" condition, the "ARTIC" reduced the mean hip extension and flexion moments by up to 92% and 48%, respectively, depending upon slope gradient. Peak vertical GRF values at terminal stance were similar to that of the able-bodied group on a downhill slope when using the ARTIC and an increased walking speed was observed during level walking when compared to the RIGID condition.

Conclusion

The Authors conclude that the effect of the microprocessor-controlled hydraulic ankle was to improve gradient walking for the amputee participant. The reduction in residual hip moment implies a benefit, which may result in a more efficient gait and decreased energy consumption as a consequence.

Products with Related Technology:

Linx, Elan