The influence of a microprocessor controlled hydraulic ankle on the kinetic symmetry of trans-tibial amputees during ramp walking: A case series

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Summary

The microprocessor-control of an Elan hydraulic ankle was switched on and off for amputees walking up and down a 5° slope. Gait analysis was performed to identify differences in the underlying walking biomechanics between the on and off conditions.

Method

Components: Elan

Measurements: 3D gait analysis

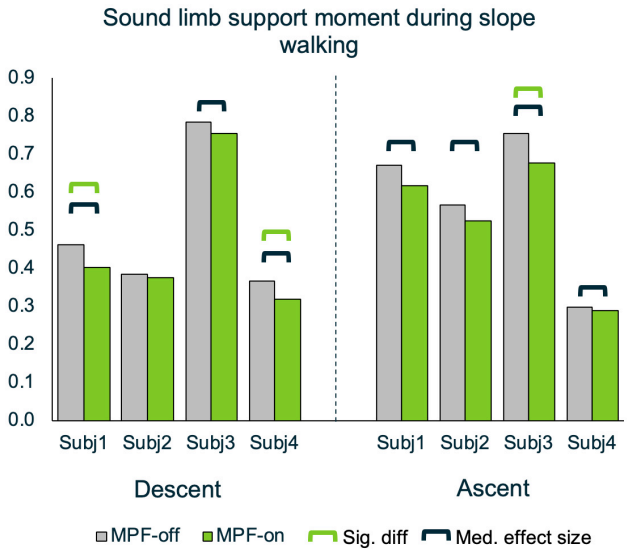
Subjects: Four trans-tibial amputees, K3 (all male; 36.8±10.6 years; 76.5±14.2kg)

Data collection protocol: 3D gait analysis was performed for two conditions (walking up and down a 5° slope) and for two prosthetic foot settings (MPF-on and MPF-off). The order of these tests was randomised and participants were given a 30 minute acclimatisation period between each trial.

Analysis: The main outcome measure was the integral of the 'support' moment curve for each limb (MI_{sup}). Degree of asymmetry (DOA) was used to compare inter-limb symmetry. Shapiro-Wilk tests were used to assess data normality, before either paired t-tests or non-parametric Wilcoxon tests identified significant differences between foot conditions. The effect size was also evaluated using Cohen's d (where d ≥0.4 was deemed a 'medium' effect size).

Results

During slope descent, the largest changes in moment integral were at the prosthetic 'ankle' for all amputees. The transition from dorsiflexion to plantarflexion moment occurred at approximately 10–20% of stance with the MPF-on, compared to approximately 20–26% of stance with the MPF-off, implying less resistance to plantarflexion and more resistance to dorsiflexion movement. Three of the four showed significant increases in prosthetic MI_{sup} (all four d ≥0.4), and two showed significant decreases in sound MI_{sup} (three of four d ≥0.4). Three had a DOA closer to 0 (i.e. improved symmetry) while the fourth showed greater reliance on the prosthetic side, than the sound side. During slope ascent, two showed significant increases in prosthetic MI_{sup}. All four showed a reduction in sound MI_{sup} (d ≥0.4).



Conclusion

The authors equate the moment-time integrals at the prosthetic 'ankle' to the MPF altering the hydraulic resistances, illustrating the 'braking' effect during descent and the 'assistance' effect during ascent. This had the effect of reducing the reliance on the sound limb during both slope descent and ascent.

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