

Walking speed related joint kinetic alterations in trans-tibial amputees: impact of hydraulic 'ankle' damping

Authors: A.R. De Asha¹, R. Munjal², J. Kulkani³, J.G. Buckley¹

¹School of Engineering, Design and Technology, University of Bradford, UK

²Mobility & Specialised Rehabilitation Centre, Northern General Hospital, Sheffield, UK

³Disablement Services Centre, University Hospital of South Manchester, UK

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Summary

The present study determined whether a trans-tibial prosthesis incorporating a dynamic-response foot that was attached to the shank via an articulating hydraulic device (hyA-F) lessened speed-related adaptations in joint kinetics compared to when the foot was attached via a rigid, non-articulating attachment (rigF).

Method

Components: Trans-tibial prostheses fitted with a range of dynamic response feet with fixed ankles as the habitual foot (habF) in comparison to a hydraulic ankle (hyA-F, Echelon).

Measurements: Kinematics, 3D motion capture gait lab (Vicon), force plates AMTI.

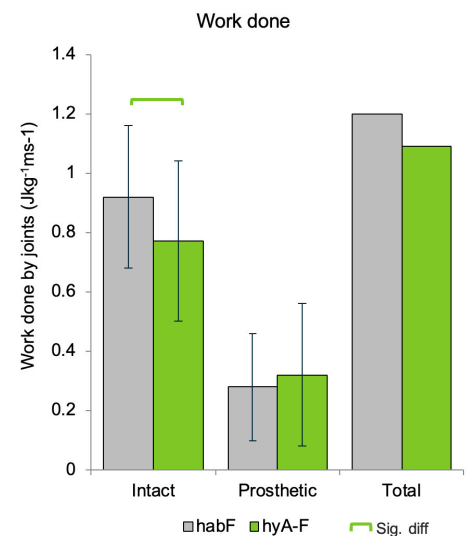
Subjects: Eight, male, unilateral, K3 trans-tibial amputees (44.8±10.7 years; 83.3±19.0kg)

Data collection protocol: Prosthetic intervention and exchange of the habF with hyA-F after period of acclimatisation, collected in 2 separate blocks, walking on a level surface at 3 self-selected speeds, customary, comfortable 'slow' and comfortable 'fast'.

Analysis: Statistical analysis, repeated measures ANOVA, attachment type and speed as repeated factors, post hoc tests.

Results

There was no change in the amount of sound-limb ankle work across speed or attachment conditions. As speed level increased there was an increase on both limbs in the amount of hip and knee joint work done, and increases on the prosthetic side were greater when using the hyA-F. However, because all walking speed levels were higher when using the hyA-F, the sound limb, ankle and combined joint's work per meter travelled were significantly lower (0.77 vs 0.92 Jkg⁻¹ms⁻¹, constituting a ~17% reduction); particularly so at the customary speed level (p=0.047). This was the case despite the hyA-F dissipating more energy during stance. Overall no significant increase in total residual joint work was observed. However, the work done per metre travelled increased at the residual knee when using the hyA-F, suggesting increased loading involvement of the prosthetic side.



Conclusion

Findings indicate that a trans-tibial prosthesis incorporating a dynamic-response foot reduced speed related changes in compensatory sound-limb joint kinetics when the foot was attached via an articulating hydraulic device compared to rigid attachment. A reduction (~17%) in muscle related energetics was observed suggesting the physical demands of walking were reduced with use of a hydraulic ankle. The authors conclude that in view of measured adaptation to joint kinetics "energy return" per se is not necessarily the key design criterion for a prosthetic foot.

Products with Related Technology:

Linx, Elan, Echelon, EchelonVT, EchelonVAC, Avalon