

# Attenuation of centre-of-pressure trajectory fluctuations under the prosthetic foot when using an articulated hydraulic ankle attachment compared to fixed attachment

**Authors:** A.R. De Asha<sup>1</sup>, L. Johnson<sup>1,2</sup>, R. Munjal<sup>3</sup>, J. Kulkarni<sup>4</sup>, J.G. Buckley<sup>1</sup>

<sup>1</sup>Division of Medical Engineering, School of Engineering, Design and Technology, University of Bradford, UK

<sup>2</sup>School of Health Studies, University of Bradford, UK

<sup>3</sup>Mobility & Specialized Rehabilitation Centre, Northern General Hospital, Sheffield, UK

<sup>4</sup>Disablement Services Centre, University Hospital of South Manchester, UK

**Published in:** Clinical Biomechanics 2013; 28(2): 218-224

## Summary

The centre-of-pressure (COP) trajectory reflects how body weight is transferred over the ankle during walking and is governed by foot and ankle design. This study sought to investigate whether COP disruptions often symptomatic as a 'dead spot' in rollover are reduced when using an articulating hydraulic ankle.

## Method

**Components:** Habitually used, dynamic response feet, with rigid, semi-rigid attachments and a hydraulic visco-elastic foot (Echelon).

**Measurements:** Kinematics and kinetics, opto-electronic motion capture (Vicon) and ground reaction force plates (AMTI).

**Subjects:** Twenty physically active trans-tibial amputees (47.4±12 years; 87.3±13.5kg).

**Data collection protocol:** P2 blocks of 10 walking trials with each foot counter-balanced across participants. All tests at freely selected comfortable walking speed.

**Analysis:** Temporal-spatial parameters and lower limb kinematics, COP trajectory and velocity.

## Results

The magnitude of the peak negative COP velocity was reduced ( $p<0.001$ ) and the distance travelled posteriorly was reduced ( $p=0.001$ ) with use of the hydraulic foot and ankle. The mean angular velocity of the prosthetic shank during double support was significantly increased ( $p<0.001$ ). Mean freely selected comfortable walking speed increased ( $p=0.001$ ) with use of the hydraulic ankle.

		Negative COP displacement (m)	Max negative COP velocity (ms <sup>-1</sup> )	Mean COP velocity variability in single support (ms <sup>-1</sup> )	Shank mean angular velocity in single support (°s <sup>-1</sup> )	Walking speed (ms <sup>-1</sup> )
habF	Mean	-0.022	-0.153	0.273	94.5	1.12
	St Dev	(0.018)	(0.110)	(0.070)	(20.2)	(0.14)
hyA-F	Mean	-0.010	-0.043	0.210	101.7	1.17
	St Dev	(0.008)	(0.066)	(0.063)	(19.2)	(0.15)

## Conclusion

The alteration to the COP trajectories, the increased angular shank velocity and the increase in freely selected customary speed suggest that the hydraulic ankle reduces the "braking" effect in roll-over of non-hydraulic foot in a way that may be functionally beneficial for active amputees.

## Products with Related Technology:

**Linx, Elan, Echelon, EchelonVT, EchelonVAC**