Impact on the biomechanics of over ground gait of using an 'Echelon' hydraulic ankle-foot device in unilateral trans-tibial and trans-femoral amputees

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Summary

In this paper the dynamics of forwards shank rotation and body centre-of-mass (COM) progression during walking was examined in unilateral trans-tibial and trans-femoral amputees. The effect of ankle foot mechanism on gait progression characteristics was determined.

Method

Components: Trans-tibial and trans-femoral 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: Nineteen K3 lower limb amputees (8 trans-femoral (42±14.8 years; 86.3±15.3kg), 11 trans-tibial (47±10.3 years; 84.5±17.3kg).

Data collection protocol: Prosthetic intervention and exchange of the habF with hyA-F after a period of acclimatisation collected in 2 separate blocks, walking on a level surface at a freely chosen walking speed.

Analysis: Spatio-temporal parameters, COM trajectory, mixed mode repeated measures ANOVA.

Results

When using the hydraulic ankle (hyA-F) both subject groups had a smoother and more rapid progression of the centre-of-pressure beneath the prosthetic hindfoot ($p<0.001$) and a smaller reduction in the centre-of-mass (COM) velocity during prosthetic stance ($p<0.001$). The freely chosen walking speed was higher in both groups when using the hyA-F ($p<0.005$). In both groups stance and swing times and the cadence were unaffected by foot condition. Step length increased bilaterally using the hydraulic device. The effect size differences between foot types was comparable across subject groups.

			Negative COP displacement (cm)	Time COP anterior to shank (% stance)	COM velocity minima during single support (ms^{-1})	Walking speed (ms^{-1})
Trans-tibial	habF	Mean	2.11	34.9	1.01	1.14
		St Dev	(0.97)	(3.5)	(0.15)	(0.14)
	hyA-F	Mean	0.82	31.8	1.09	1.22
		St Dev	(0.64)	(4.1)	(0.15)	(0.11)
Trans-femoral	habF	Mean	1.21	33.7	0.83	0.94
		St Dev	(1.51)	(7.7)	(0.17)	(0.11)
	hyA-F	Mean	0.35	26.9	0.89	0.99
		St Dev	(0.39)	(6.4)	(0.20)	(0.10)

Conclusion

The authors conclude that use of a hydraulic ankle-foot device reduced the foot's "braking" effect (resistance to forwards progression) for both amputee groups. The findings suggest that attenuation of the braking effect from the foot in early stance may be more important to prosthetic-foot function than its ability to return energy in late stance.

Products with Related Technology:

Linx, Elan, Echelon, EchelonVT, EchelonVAC, Avalon