Reference

Beck ON, Taboga P, Grabowski AM.

Department of Integrative Physiology, University of Colorado, Boulder CO / Department of Veterans Affairs, Eastern Colorado Healthcare System, Denver, CO.

How do prosthetic stiffness, height and running speed affect the biomechanics of athletes with bilateral transtibial amputations?

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Products

IE90 Sprinter Foot

Major Findings

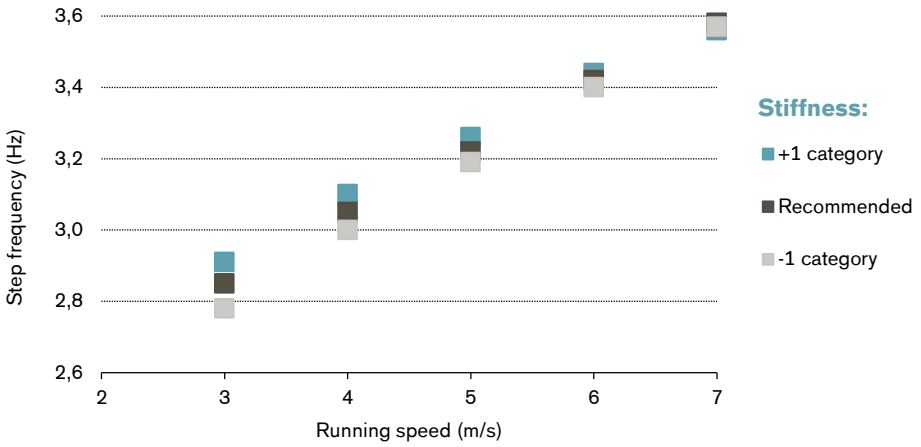
With IE90 compared to Catapult FX6 (Freedom Innovations) and Cheetah Xtend (Össur):

→ **Prosthetic stiffness, height and running speed all affected biomechanics of running**

The use of a stiff running-specific prosthesis (RSP) increases overall leg stiffness and step frequency

The Influence of prosthetic stiffness on biomechanics reduced at faster running speeds

Step frequency at three different stiffness categories (average of all 3 prosthetic models)



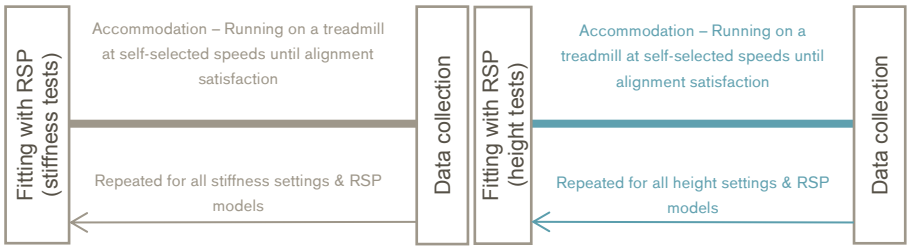
The use of stiffer RSPs resulted in increased overall leg stiffness and step frequency; however, the influence of prosthetic stiffness on biomechanics was mitigated at faster running speeds, as hypothesized by the authors.

Population

Subjects:	5 male, bilateral, transtibial amputee athletes
Previous prosthesis:	passive-elastic running-specific prosthesis (RSP)
Amputation causes:	congenital (60%), trauma (20%), infection (20%)
Mean age:	24.8 ± 4.8 years
Mean time since amputation:	not reported
MFCL:	not reported

Study Design

Interventional, randomized, crossover trial



"Participants performed a session of one to three sets of treadmill running trials. […] A successful trial was determined if the participant was able to maintain forward position on the treadmill while taking 20 consecutive steps. […] Each participant ran using 15 different combinations of prosthetic model, stiffness category and height. At first, participants ran using each model at three different stiffness categories at the IPC maximum competition height. […] Subsequently, participants ran using the optimal stiffness category of each prosthetic model at two additional heights" (Beck et al., 2017)

Results

Activities		Participation				Body function			Other
Sprinting, running, jumping	Other sports	Leisure / recreational sports	Competitive sports	Paralympic sports	Preference, satisfaction, QoL	**Biomechanics (kinematics / kinetics)**	Clinical (metabolic / performance)	Medical (pain, injuries)	Technical aspects / alignment

Category	Outcomes	Results for IE90 Sprinter	Sig.*
Biomechanics (kinematics / kinetics)	Effect of prosthetic stiffness increase (1 kN/m) on biomechanics	Significant (p<0.001) effect on: - overall leg stiffness (increased) - residual limb stiffness (decreased) - contact length (decreased) - contact time (decreased) - step frequency (increased) - angle of leg spring at ground contact (increased, p=0.012) - peak vertical displacement of center of mass (decreased) - peak vertical GRF (increased) - peak leg spring compression (decreased) - stance average vertical GRF (increased)	++
	Effect of prosthetic height increase (2cm) on biomechanics	Significant (p<0.001) effect on: - contact length (increased) - contact time (increased) - step frequency (decreased, p=0.009) - angle of leg spring at ground contact (decreased) - peak vertical displacement of center of mass (increased) - peak vertical GRF (decreased) - peak leg spring compression (decreased) - stance average vertical GRF (decreased)	++
	Effect of running speed increase (1 m/s) on biomechanics	Significant (p<0.001) effect on: - overall leg stiffness (decreased) - residual limb stiffness (decreased) - contact length (increased)	++

Category	Outcomes	Results for IE90 Sprinter	Sig.*
		- contact time (decreased) - step frequency (increased) - angle of leg spring at ground contact (increased) - peak vertical displacement of center of mass (decreased) - peak leg spring compression (increased) - stance average vertical GRF (increased)	

* no difference (0), positive trend (+), negative trend (–), significant (++/––), not applicable (n.a.)

Author's Conclusion

"Athletes with bilateral transtibial amputations change their running biomechanics when using RSPs that differ in stiffness, height and while running at different speeds. Namely, the use of stiffer RSPs increased leg stiffness, step frequency, peak and stance average vertical GRF production, and decreased ground contact time. The use of taller RSPs increased step length. Running speed was inversely associated with leg stiffness. Moreover, faster running speeds mitigate the effect of prosthetic stiffness, but not height, on running biomechanics. Therefore, prosthetic stiffness, but not height, likely has a greater influence on distance running performance than on sprinting performance for athletes with bilateral transtibial amputations." (Beck et al. 2017)