The Relationship Between Vertical Loadrates and Tibial Acceleration Across Footstrike Patterns

Irene Davis, PhD, PT, Todd Hayano, DO, Adam Tenforde

Category: Other

Keywords: Tibial Acceleration; vertical loadrate; runner; running medicine; instrumented treadmill; tri-axial tibial accelerometer; forefoot; midfoot; hindfoot

Introduction/Purpose: While the etiology of injuries is multifactorial, impact loading, as measured by the loadrate of the vertical ground reaction force has been implicated. These loadrates are typically measured with a force plate. However, this limits the measure of impacts to laboratory environments. Tibial acceleration, another measure of running impacts, is considered a surrogate for loadrate. It can be measured using new wearable technology that can be used in a runner's natural environment. However, the correlation between tibial acceleration measured from mobile devices and vertical ground reaction force loadrates, measured from forceplates, is unknown. The purpose of this study was to determine the correlation between vertical and resultant loadrates to vertical and resultant tibial acceleration across different footstrike patterns (FSP) in runners.

Methods: The study involved a sample of convenience made up of 169 runners (74 F, 95 M; age: 38.66±13.08 yrs) presenting at a running injury clinic. This included 25 habitual forefoot strike (FFS), 17 midfoot strike (MFS) and 127 rearfoot strike (RFS) runners. Participants ran on an instrumented treadmill (average speed 2.52±0.25 m/s), with a tri-axial accelerometer attached at the left distal medial tibia. Only subjects running with pain <3/10 on a VAS scale during the treadmill run were included to reduce the confounding effect of pain. Vertical average, vertical instantaneous and resultant instantaneous loadrates (VALR, VILR and RILR) and peak vertical and resultant tibial accelerations (VTA, RTA) were averaged for 8 consecutive left steps. Correlation coefficients (r) were calculated between tibial accelerations and loadrates.

Results: All tibial accelerations were significantly correlated across all loadrates, with the exception of RTA with VILR for FFS (Table 1) which was nearly significant (p=0.068). Correlations ranged from 0.37-0.82. VTA was strongly correlated with all loadrates (r = 0.66). RTA was also strongly correlated with both loadrates for RFS and MFS, but only moderately correlated with loadrates for FFS (r = 0.47). Correlations were similar across the different loadrates (VALR, VILR, RILR).

Conclusion: The stronger correlation between vertical tibial acceleration and all loadrates (VALR, VILR, RILR) suggests that it may be the best surrogate for loadrates when studying impact loading in runners.

		VALR		VILR		RILR	
	FSP	*r*	*p-value*	*r*	*p-value*	*r*	*p-value*
VTA	*FFS*	0.82	<0.001	0.69	<0.001	0.70	<0.001
	MFS	0.74	<0.001	0.73	<0.001	0.73	<0.001
	RFS	0.66	<0.001	0.66	<0.001	0.67	<0.001
	All	0.72	<0.001	0.72	<0.001	0.72	<0.001
RTA	*FFS*	0.47	0.018	0.37	0.068	0.41	0.042
	MFS	0.63	0.007	0.66	0.004	0.68	0.002
	RFS	0.67	<0.001	0.67	<0.001	0.68	<0.001
	All	0.39	<0.001	0.43	<0.001	0.45	<0.001

Foot & Ankle Orthopaedics, 3(3)
DOI: 10.1177/2473011418S00200