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Multi-directional peak tibial accelerations in over-ground, level, running: a multicenter study

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Summary

Loading of the musculoskeletal system has been key in the foot strike pattern debate. This multi-center study evaluated whether multi-directional peak tibial acceleration (PTA) behave similarly between foot strike patterns. 3D tibial accelerations were separately collected and processed in-lab and in-field at respectively ~3.2 and 3.3 m/s. Motion data was additionally captured in-lab. Resultant PTA was higher during instructed (+88%) and habitual (+46%) non-rearfoot striking compared to habitual rearfoot striking because of an abrupt decrease in transverse velocity of the shank during non-rearfoot striking. Non-rearfoot runners have a higher total tibial shock because of a diminished anterior 'braking path'.

Introduction

During over-ground running, PTA has generally been evaluated in the axial direction. Axial PTA is of specific interest as high axial PTA has been associated to tibial stress fracture in rearfoot runners [1]. The interest in the resultant PTA is however increasing because it provides a more complete measure of shock [2-4]. While axial PTA can be smaller on treadmill in non-rearfoot runners compared to rearfoot runners [5], a preliminary and treadmill-based study reported greater resultant PTA during non-rearfoot running [4]. This multicenter study evaluated multi-directional PTAs between foot strike patterns during over-ground running in neutral footwear at a common speed for distance running.

Methods

Empirical evidence was gathered separately for parted processing by the cite from which they were collected. For the in-lab part, 14 habitual rearfoot runners (32.1±12.6 yrs., 1.75±0.09 m, 69.1±8.8 kg) ran at ~3.2 m/s across a 32-m runway with a rearfoot strike and non-rearfoot strike ('land on the ball of the foot'). They were equipped with a light backpack system connected to a low-weight 3D accelerometer (1000 Hz) tightly affixed at the right lower leg [2]. Lower extremity kinematics were recorded using motion capture (Oqus, Qualisys). Three successful trials per participant per running condition were processed as in [3]. The in-field part consisted of 14 habitual rearfoot (45.6±8.6 yrs., 1.75±0.06 m, 71.9±10.8 kg) and 9 habitual non-rearfoot (30.9±10.4 yrs., 1.77±0.06 m, 71.0±8.2 kg) male runners performing a 20-m run on an asphalt track at ~3.3 m/s. A 3D accelerometer capturing accelerations (1344 Hz) was firmly fixed to the left lower leg [2]. Tibial accelerations were processed as in [2]. Paired sample T-tests evaluated differences between the in-lab habitual rearfoot and instructed non-rearfoot striking conditions for PTAs and shank kinematics. Independent sample T-tests evaluated PTAs between habitual rearfoot and habitual non-rearfoot runners (two-tailed, α=0.05; SPSS v25).

Results and Discussion

Both habitual non-rearfoot and instructed non-rearfoot running had greater resultant but not axial PTAs compared to habitual rearfoot running (table 1). This finding stems with a preliminary, treadmill-based study wherein runners also experienced higher resultant PTA during non-rearfoot compared to rearfoot striking [4]. Shank vertical touchdown velocities were similar (p=0.136). Though non-rearfoot striking was characterized by a slightly smaller fore-aft touchdown velocity than rearfoot striking, there was a greater (p<0.001, 95% CI: 0.54, 1.03) decrease in this transverse velocity following touchdown in non-rearfoot ($\bar{x}$=-1.1) versus rearfoot ($\bar{x}$=-0.3) striking. The deceleration of the shank's forward momentum happened faster, resulting in a higher transverse PTA and consequently resultant PTA.

Conclusions

Non-rearfoot running does not guarantee smaller total tibial shock during over-ground, level running at submaximal speed. These results have implications for running retraining research that alters running style by means of biofeedback on a particular component of PTA and/or that imposes forefoot striking for habitual rearfoot runners.

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References

[1] Milner et al. (2006). MSSE,38:323–8; [2] Giandolini et al. (2016). J Biomech,49:1765–71; [3] Van den Berghe et al. (2018). Proceedings of the WCB, O0486; [4] Glauberman & Cavanagh. (2014) J Foot Ankle Res,7:A93. [5] Gruber et al. (2014). JSHS,3:113–21.

Table 1: Within- and between-subject comparisons of peak tibial acceleration (PTA) between foot strike patterns. $\Delta\bar{x}$: mean difference.

Comparison of peak	In-lab: instructed non-rearfoot minus habitual rearfoot			In-field: habitual non-rearfoot versus habitual rearfoot		
	$\Delta\bar{x}$ (g)	95% CI	*p*	$\Delta\bar{x}$ (g)	95% CI	*p*
Resultant PTA	7.62	4.92, 10.32	< 0.001	3.70	1.34, 6.05	0.004
Axial PTA	-0.45	-1.37, 0.47	0.307	1.40	-0.41, 3.20	0.116
Transverse PTA	9.10	6.74, 11.45	< 0.001	4.8	2.30, 7.30	0.001