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In:

BILATERAL TENDON STRAIN DURING A 5-KM RUNNING TIME-TRIAL

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Summary

Strain is an important mechanical stimulus for adaptation of biological tissues such as tendons. Triathletes frequently suffer from chronic tendon injuries [1], but investigations on tissue strain are lacking for this population. We investigated triceps surae tendon strain in triathletes during running after cycling using a kinematics-based musculoskeletal model.

Methods

Eight competitive triathletes (mean±SD: 32±5 years, 71±7 kg, 176±5 cm) performed 20 mins cycling on a cycle-ergometer (LC7, Monark Exercise AB, Sweden) followed by a 5-km running time-trial on a motorized treadmill (RL2500E, Rodby Innovation AB, Sweden). A musculoskeletal model [2] was scaled for each triathlete following standard procedures presented in [3]. Ankle and knee joint kinematics during three different running stages (start, mid and end) were computed by the Inverse Kinematics tool in [2], while triceps surae tendon lengths were assessed by the Muscle Analysis tool [2]. Ten stance phases for each leg were averaged in each running stage. Toe-strike and toe-off were defined by a 50N ground reaction force threshold recorded by a pressure measuring insole system (Pedar®, Novel GmbH, Germany). Mean ankle, knee joint angles and tendon lengths were computed and averaged from toe-strike to peak ground reaction force. Medial gastrocnemius (MG), lateral gastrocnemius (LG) and soleus (SOL) tendon strain were assessed by normalizing tendon length by their respective tendon slack length. Leg preference was determined based on a footedness questionnaire [4]. Data normality assumption was checked with the Shapiro-Wilk tests. Significant and/or important differences were inferred from Paired Sample T-Tests and Cohen's d for a 95% confidence interval computed with a free statistical package (JASP v0.9.1 - http://jasp-stats.org).

Results and Discussion

Although the small sample size of this study does not provide strong statistical power, the results suggest no significant effect of leg preference on joint kinematics and tendon strain (Table 1). Thus, triathletes in this study presumably do not expose their tendons to unequal strains during running. Important to note is that joint kinematics may not represent tendon behavior due to complex interactions between muscle and tendon tissues (e.g. gearing).

Generic musculoskeletal models in [2] assume equal tendon length and strain between legs by default, what in practice may not be the case [5]. Functional symmetry may occur in dynamic tasks such as running, although studies investigating this assumption are lacking. Assuming symmetry in muscle-tendon properties such as strain could have implications for training periodization and musculoskeletal simulations. These strategies may be relevant when aiming to prevent or to treat chronic tendon injuries. Therefore, symmetry in tendon strain during running needs to be further experimentally confirmed.

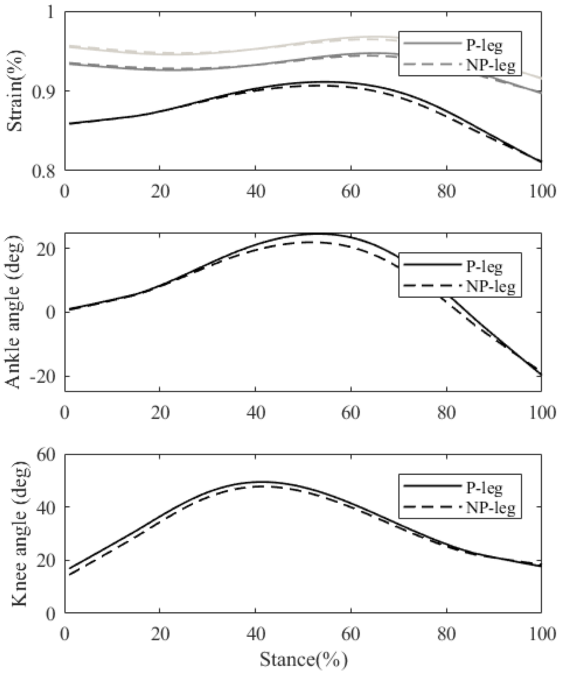
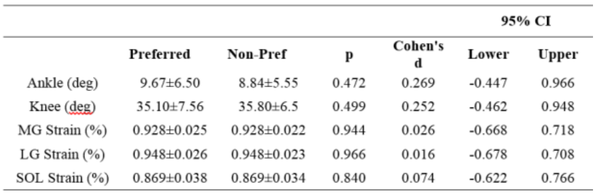


Figure 1. Mean tendon strain (top panel: MG (light grey lines), LG (dark grey lines) and SOL (black lines)) and joint kinematics during the complete 5-km run. P-leg: preferred leg; NP-leg: non-preferred leg.

Table 1. Mean±SD values for joint kinematics and tendon strain during the loading phase of the 5-km running.



					95% CI	
	Preferred	Non-Pref	p	Cohen's d	Lower	Upper
Ankle (deg)	9.67±6.50	8.84±5.55	0.472	0.269	-0.447	0.966
Knee (deg)	35.10±7.56	35.80±6.5	0.499	0.252	-0.462	0.948
MG Strain (%)	0.928±0.025	0.928±0.022	0.944	0.026	-0.668	0.718
LG Strain (%)	0.948±0.026	0.948±0.023	0.966	0.016	-0.678	0.708
SOL Strain (%)	0.869±0.038	0.869±0.034	0.840	0.074	-0.622	0.766

Conclusions

No important differences in bilateral tendon strain were observed during a 5km running trial after cycling. Possible differences in estimated *vs* experimentally measured strain should be addressed in future studies.

Acknowledgements

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