

Topic: Energy Cost in the Calf Muscles for Different Running Styles

Forefoot and rearfoot running are two commonly used running styles. The triceps surae (muscles in the calf) is used differently between these running styles. This muscle group absorbs energy and produces greater muscle force in forefoot running than in rearfoot running [1]. This indicates that forefoot running requires more energy than rearfoot running. However, forefoot runners often are faster in long distance races [2], and measurements of whole-body energy consumption show that the energy cost is similar between forefoot and rearfoot running [3].

Recent work also suggested that the energy expenditure in the triceps surae muscle was not different between forefoot and rearfoot running [1]. However, these results are affected by modelling decisions, for example the methods used to calculate energy expenditure and the stiffness of the triceps surae muscle. Therefore, with this thesis, we would like to further investigate the effect of different modelling decisions on the calculated energy expenditure in the triceps surae.

The goal of this project is to analyse the energy cost of the triceps surae muscle group and compare the energy cost of running with a forefoot and rearfoot pattern. Biomechanical simulations of running will be created, such that the energy cost of individual muscles can be calculated and compared. Secondly, a sensitivity analysis will be performed on different parameters of the triceps surae muscle to understand how these parameters affect the solution.

The proposed work consists of the following parts:

- Design and implementation of a sensitivity study of different muscle parameters in the triceps surae
- Creation of biomechanical simulations of running with different footstrike patterns with different muscle parameters
- Analysis of the kinetics and kinematics of the simulations and comparison to previous work
- Evaluation of whole-body and triceps surae energy cost of both running styles
- Statistical comparison of the energy cost in the triceps surae muscle between forefoot and rearfoot runners

The thesis must contain a detailed description of all developed and used algorithms as well as a profound result evaluation and discussion. The implemented code has to be documented and provided.

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Student:
Start – End:

References

- [1] Swinnen, Wannas et al.: *Habitual foot strike pattern does not affect simulated Triceps Surae muscle metabolic energy consumption during running*. bioRxiv preprint, 2019.
- [2] de Almeida, MO et al.: *Is the rearfoot pattern the most frequently foot strike pattern among recreational shod distance runners?* Phys Ther Sport, 16: 29–33, 2015.
- [3] Gruber, Allison et al.: *Economy and rate of carbohydrate oxidation during running with rearfoot and forefoot strike patterns*. J Appl Physiol, 115: 194–201, 2013.