Comments on the article by Jinha et al. “A task-specific validation of homogeneous non-linear optimisation approaches”
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Letter to the Editor

Dear Editor

We read with great interest the article by Jinha et al. “A task-specific validation of homogeneous non-linear optimisation approaches” (2008, vol. 259, pp. 695–700). The article studies the important issue of muscle recruitment using nonlinear convex optimisation and concludes: “that convex homogenous nonlinear optimisation approaches cannot predict individual muscle forces properly, as force-sharing among synergistic muscles obtained experimentally are not just scaled versions of joint loading, not even in a first approximation”. Although the experimental data used appear to be well collected, we believe that the mathematical treatment and study setup contains several errors and limitations that have significant impact on the article’s findings.

(1) From Eqs. (5) to (6), the authors use that limitations that have significant impact on the article’s findings.

(2) Using Eqs. (4) to (6), it is stated that, given two different resultant joint moment vectors, which are scaled versions of each other, the remaining joint moments of the cat were included in the analysis, they would also be collinear. (2) There may be a significant change in muscle moment arms between the compared situations, which is not controlled in the study or captured by the model. Due to these uncontrolled variables, it is not possible to determine whether the mismatch between the modelled and measured muscle forces is due to the muscle recruitment criterion or the excluded elements in the model.

To improve the study, we recommend to: (1) extend the analysis to also include the joint moments of the hip and include trunk origin points for muscles crossing the hip due to their importance for the equilibrium at the hip. (2) Quantify the variations in muscle moment arms and ensure that their variations are insignificant.

Since the authors have access to valuable measured muscle force data for model validation purposes, which are not available in the majority of studies, we recommend that the authors build a 3D musculoskeletal model of the cat hind limb that can take into account the effect of changing muscle moment arms and the effects of bi-articular muscles crossing the hip, knee and ankle. With this model, the commonly used convex muscle recruitment criteria can be examined for the different functional trials of the cat and the predicted forces evaluated quantitatively. Because all musculoskeletal models include uncertainties, the confidence in the results could be increased by computing the muscle forces as a function of uncertainties in the model parameters to obtain a range of possible computed muscle forces. If the measured muscle forces fall outside this range, it is likely that the applied muscle recruitment criterion is not correct. Otherwise the mismatch between the nominal musculoskeletal model and the measured muscle forces can be due to model uncertainties.

Muscle recruitment is indeed a challenging field of science requiring complex models and devoid of a gold standard because it is practically infeasible to measure muscle forces in vivo.
Numerous papers on the subject (van Bolhuis and Gielen, 1999; Happee and Van Der Helm, 1995; Praagman et al., 2006) have found reasonable but definitely less than perfect matches between model predictions and experimental data, and the entire field contains many open questions. In view of this situation, the work of Jinha et al. discussed in this letter is most welcome. The interested reader may refer to a recent review by Erdemir et al. (2007) of different approaches and to an even more recent result speaking in favour of a minimum fatigue criterion (Ackermann and van den Bogert, 2010).

References


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