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EMG-DRIVEN ESTIMATION OF MUSCLE MOMENTS REVISITED THROUGH INTEGRATION OF INTERMUSCULAR COHERENCE

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1. Introduction

The accurate estimation of mechanical efforts developed by the muscles involved in motor action is of great interest in biomechanics and all related fields. Despite a number of existing (neuro)musculoskeletal models, neural strategies are still poorly exploited while they can contribute to improve estimations of muscle efforts [1]. Neural strategies can be quantified with intermuscular coherence (IMC), i.e., the frequency correlation between two electromyographic (EMG) signals [2]. The aim of the present study is to integrate IMC into an EMG-driven neuromusculoskeletal model to improve the estimation of muscle moments.

2. Materials and Methods

Surface EMG and 3D kinematics of the right upper limb were recorded on 24 healthy subjects performing 10 self-paced in-plane full elbow extensions. The elbow net joint torque was calculated with inverse dynamics. IMC was calculated between the pairs of elbow extensors and flexors [3]. IMC results were used to split each recorded EMG signal into independent and common components further used as input data in an EMG-driven minmax optimization-based musculoskeletal model inspired by [4] and generalized to the upper limb. Estimation of muscle moments and related cocontraction index were compared to those obtained with the same model [4] without integration of IMC.

3. Results

The tracking of elbow net torque calculated with inverse dynamics is similar for both models, but the optimization doesn't converge for 4 subjects without integration of IMC. Furthermore, the estimations are more physiologically realist with IMC: the antagonist moments are not neglected while, without IMC, they are zeroed over more than half of the movement for some subjects.

The cocontraction index calculated between agonist and antagonist muscle moments was significantly higher at ~7-37% ($p<0.001$) and lower at ~77-83% ($p<0.001$) and ~97-100% ($p=0.02$) of the extension movement with IMC than without.

4. Discussion and Conclusions

In line with the view that it is necessary to consider neural strategies for consistently improving the estimation of muscle efforts, our results provide strong evidence that the determination of independent and common neural component through IMC improves the physiological interpretation of muscle moments estimation and related metrics. This finding pleads for the integration of IMC in musculoskeletal models to obtain more realistic and interpretable estimates of muscle moments in both healthy and clinical populations.

5. References

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