Muscle mechanical energy is an important quantity to be analysed in human locomotion, since it reflects the neuromuscular strategies used by the nervous system, and is directly related to the efficiency of the movement (1,2). The performance of different motor tasks requires the coordination of a number of muscles involved. An accurate determination of muscle function requires the quantification of the contributions of individual muscles to the energetics of a given body segment (3). The computational muscular decomposition is the most promising solution to obtain a muscular injury figure and insights on energy transfer. A Forward-Inverse Dynamics Model was used to estimate the individual muscles forces and joint moments for some individual muscles of the lower limb, during the performance of moderate and high impact ballet jumps. To illustrate the application of the proposed method, three professional ballet dancers participate in the study. Kinematical and dynamical data were obtained from high speed video and a Kistler force plate. Surface Electromyographic activities from the adductor, vastus lateralis, vastus medialis, hamstrings, medial gastrocnemius, tibialis anterior, and soleus muscles were collected. In all subjects, mechanical energy values were especially higher in the distal end of rectus femoris and gastrocnemius, vastus, and soleus muscles, in moderate and high impact jumps. The ankle and knee are flexing in the landing phase and so, as expected, all these muscles work eccentrically. The mechanical energy transfer between segments was estimated in the proximal and distal joints, for the gastrocnemius muscle group, rectus femoris muscle, and hamstrings muscle group, during the performance of moderate and high impact jumps. The energy transfer mechanism was apparent in all subjects for almost all cases, at least in high impact jumps. In subject B the energy transfer was used in all moderate and high impact jumps and, interestingly, this subject was technically considered the best performer. The results suggest that the forces of bi-articular muscles are organized in order to provide efficient performance of jumps. The gastrocnemius might be especially useful in distributing mechanical energy between the ankle and the knee when there is an increase demand for mechanical energy to be absorbed or generated at the ankle joint. Nevertheless, the behaviour of the muscles involved is dependent on the technique used in the performance. Small external changes can result in significant internal changes. The usage of a hybrid forward-inverse dynamics model seems to desensitise it from the objective function and was considered appropriated and effective in estimating the muscle forces in dynamic exercises.

References:
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