IMPACT OF THE ATHLETES’ ANTHROPOMETRY ON THE OPTIMAL ACROBATICS TECHNIQUES

Eve Charbonneau1, Lisa Sechoir2, Francisco Pascoa3, Pierre Puchaud1, Mickaël Begon1
1Department of Medicine, Université de Montréal, Montréal, Canada
2École centrale de Marseille, Marseille, France
3Department of arts sciences, Université de Montréal, Montréal, Canada
*eve.charbonneau.1@umontreal.ca

ABSTRACT

In acrobatic sports, athletes perform multiple rotations around multiple axes simultaneously while airborne. Currently, coaches rely greatly on visual inspection and personal experience to approach the biomechanics of acrobatics. Therefore, it is currently a challenge for them to innovate. Predictive computer simulation could help coaches identify athlete-specific optimal acrobatic techniques which could improve sports performance. The objective of this study was to assess the effect of anthropometry on optimal acrobatic techniques.

We measured the anthropometric characteristics of 18 national athletes from acrobatic sports (9 male and 9 female, mass ranging from 46.7 kg to 81.7 kg, height ranging from 153.7 cm to 185.3 cm) to generate their multi-body dynamic model in line with Yeadon (1990). The models were torque driven with the following degrees of freedom: 6 at the free-floating base, 2 at each shoulder, 2 at each elbow, and 2 at the joined hips. Double forward somersaults in pike position ending with either 1.5 or 2.5 twists were generated for each model using optimal control with a direct multiple shooting transcription (380 shooting intervals). The constraints of the problem insured that the proper acrobatic was executed within the physiological range. The objective function favored techniques in line with the sport’s regulations; regularisation terms were added to help convergence. A multi-start approach was used to avoid local minima. The kinematics of optimal techniques were compared to assess the effect of anthropometry.

Optimal techniques were found for all anthropometric models. Four clusters of solutions could be identified. Solutions in the clusters were adapted to the models’ anthropometries by modifying the amplitude of the actions up to 10%. These clusters of solutions used a common strategy: a circular motion of the hips to generate the twist, followed by asynchronous arm adduction to untill the body before landing. This strategy is similar to the behavior of elite athletes when executing the acrobatic with 1.5 twists. Anthropometry-specific strategies were also found; they differed from this general strategy in terms of optimal cost function value and kinematics.

The confirmation that the technique used by most athletes is optimal for most anthropometries might be comforting for coaches with younger athletes that are still growing since only amplitude will be adjusted over time. Coaches might provide better instructions if they considered the amplitude modifications needed for their athletes’ anthropometry. Athletes with particular anthropometry might improve their performance by learning an innovative strategy found in this study.