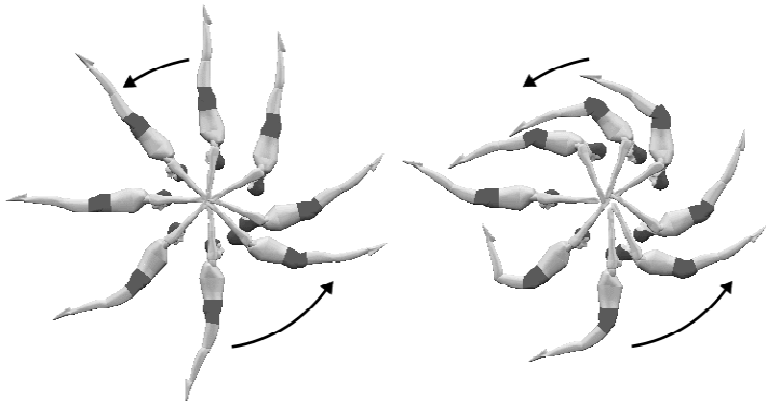
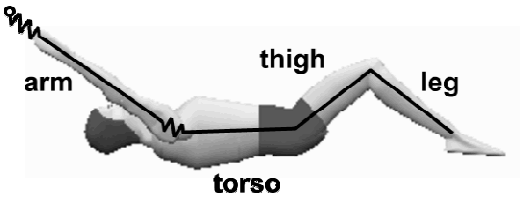
Hiley, M.J. and Yeadon, M.R. 2003. Optimum technique for generating angular momentum in accelerated backward giant circles prior to a dismount. Journal of Applied Biomechanics 19, 119-130.

In Men's Artistic Gymnastics the backward giant circle on high bar is used to produce the angular momentum that the gymnast needs to perform somersaulting dismounts. Dismounts where the gymnast performs two somersaults in the layout (straight body) position require the greatest angular momentum (Kerwin, Yeadon and Lee, 1990). However, there appear to be two distinct techniques used by elite gymnasts when performing backward giant circles prior to a double layout somersault dismount. The “traditional” technique has been superseded by the “scooped” technique which is now used by the majority of elite gymnasts.



To determine whether the scooped technique was better at producing angular momentum a simulation model was used to optimise the angular momentum about the mass centre at release. The four segment planar simulation model comprised arm, torso, thigh and lower leg segments with the high bar and the gymnast's shoulder structure modelled as damped linear springs. Model parameters comprised the segmental inertia parameters, the stiffness and damping coefficients of the bar and shoulder springs, and parameters defining the maximum torque at each joint. Model input consisted of the initial displacement and velocity of the bar, the initial orientation and angular velocity of the arm, and the joint angle time histories. The equations of motion for the model were derived using Newton's Second Law and by taking moments about the neutral bar position and the segment mass centres.



The model was evaluated using data obtained from a force - video analysis of accelerated giant circles. The model was able to estimate the reaction forces measured by strain gauges on the bar to within 9% of the peak forces and the body rotation angle to within 1% of the total rotation.

During the optimisations the joint angle time histories of the model were manipulated in order maximise the angular momentum about the model's mass centre at release. To avoid joint angle time histories which exceeded the strength capabilities of the gymnast, the surface fits which expressed torque as a function of angle and angular velocity were used to limit the joint torques at the hip and shoulder (King and Yeadon, 2002) . Two optima were found which were characteristic of the two backward giant circle techniques used by elite gymnasts. The traditional technique produced more angular momentum than the scooped technique although both techniques were capable of producing sufficient angular momentum for a double layout somersault dismount. As a consequence the preference of elite gymnasts for the scooped technique must be based on factors other than the production of angular momentum.

Related Papers

Hiley, M.J. and Yeadon, M.R. 2003. The margin for error when releasing the high bar for dismounts. Journal of Biomechanics 36, 313-319.

Kerwin, D.G., Yeadon, M.R. and Lee, S. 1990. Body configuration in multiple somersault high bar dismounts. International Journal of Sport Biomechanics 6, 2, 147-156.

King, M.A. and Yeadon, M.R. 2002. Determining subject specific torque parameters for use in a torque driven simulation model of dynamic jumping. Journal of Applied Biomechanics 18, 207-217.