

PHYSIOLOGICALLY REASONABLE 'TORQUE REVERSAL' CAUSED IN COMPUTER-SIMULATED PLANAR BALL THROWING DOES NOT INCREASE BALL SPEED AT RELEASE

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KEYWORDS: ball throwing, torque reversal speed, mathematical model

INTRODUCTION: Herring and Chapman (1992) reported that some torque reversals caused by the agonist deactivation and the antagonist activation at the proximal joints of a planar three link segment model for ball throwing with the upper extremity increased ball speed at ball release. The paper has often been referred as the study showing possible positive roles of antagonisms for planar motions (Sorensen et al. 1996; Do"rge et al., 1999) in spite of its unrealistically rapid torque reversal for human movements. The purpose of this study was to investigate influences of the speeds of the deactivation and activation on the ball speed in computer-simulated ball throwing using a model similar to that used by Herring and Chapman (1992).

METHODS: Ball throwing was simulated using a mathematical planar three link segment model which was the same as that used by Herring and Chapman (1992) except the properties of torque generators (TGs). The model was comprised of the upper arm, forearm, hand and a ball. There were three Hill-typed TGs at the shoulder, elbow and wrist joints for agonists, and two same typed TGs at the proximal joints for antagonists. Two kinds of speeds of the deactivation for the agonists and the activation for the antagonists were used as follows : 1) a speed similar to that produced by the intact human muscles and 2) an unrealistically rapid speed which was the same as that used by Herring and Chapman (1992).

RESULTS AND DISCUSSION: Unrealistically rapid torque reversals at the proximal joints increased the ball speed at ball release by about 3 % while the speed scarcely changed when the speeds of the deactivation of agonists and the activation of antagonists were within physiologically reasonable ranges.

The joint reaction force at the wrist joint brought about by the 'torque reversal' acts to decrease the speed of the center of mass of the hand plus ball, and to increase the rotational speed of the hand plus ball. The effect of the 'torque reversal' on the rotational speed depends on how far the ball is located from the center. The distance of the ball from the center in the model was by a narrow margin for the increase in ball speed by 'torque reversal'. Hence, a small change in joint reaction force at the wrist joint brought about by the reasonable 'torque reversal' failed to produce a meaningful increase in ball speed at the release. Contrary, the unrealistically rapid torque reversal produced a huge reaction force at the joint and resulted in the meaningful increase in ball speed in spite of the narrow margin.

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