LINEAR AND ANGULAR MOMENTUM OF THE UPPER BODY IN TENNIS FOREHANDS

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INTRODUCTION: Linear momentum and angular momentum are said to be the two sources of power in the tennis forehand and they "should act together in a coordinated manner" (Groppel, 1992). However, the relationship between them has not been investigated. Thus, the purposes of this study were to determine linear and angular momentum of the upper body in tennis forehands and to investigate their coordination.

METHOD: Seven advanced male collegiate tennis players hit tennis forehand ground strokes using square and open stance techniques with each foot on a separate force plate. Two phase-locked cine cameras were used to film the strokes at a nominal rate of 200 frames per second. Three dimensional coordinates of markers attached to the subjects were determined using a DLT method. Joint forces and torques at the lower limbs were determined using inverse dynamics. The sum of the impulses of the right and left hip joint forces in the global forward direction (the direction of the shot) and the angular impulse of the pelvic torque were calculated. The pelvic torque was defined as the torque acting on the pelvis about its superior-inferior axis passing through the midpoint between the right and left hip joint centers, and was calculated as the sum of hip joint force and moment components (Iino and Kojima, 2001). The interval of integration in calculations of the impulses was from the time instant when the lead foot left the ground to step in to the instant of ball impact.

RESULTS: Kinematically, the pelvis first moved linearly forward and then rotated forward. There were significant strong correlations between the linear and angular impulses for both square and open stance forehands (Fig. 1). The linear impulse was significantly correlated with the angular impulse of the joint torque component of the pelvic torque but was not significantly correlated with that of the joint force component. The angular impulse was not significantly correlated with the maximum value of the pelvic angular velocity.

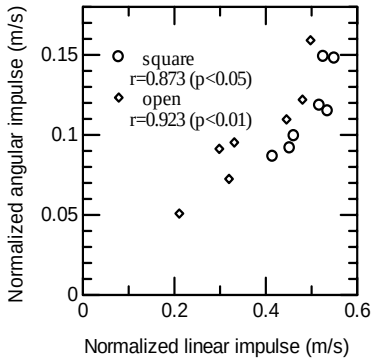

Fig. 1: Relationship between linear and angular impulses.

DISCUSSION: In tennis forehands, the linear forward movement of the upper body usually precedes its rotation. Thus, the results suggest that the linear forward movement is necessary to achieve substantial rotation of the upper body and helps the hip joint torques rather than the hip joint forces contribute to the pelvic rotation.

CONCLUSION: It is suggested that one function of the linear forward movement is to achieve substantial upper body rotation.

REFERENCES:

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