KINEMATICS OF CLEAR IN JUNIOR BADMINTON PLAYERS

Pekka H. Luhtanen and Minna T. Blomqvist

Research Institute for Olympic Sports, Jyväskylä, Finland

INTRODUCTION

The motion of rotating body segments of different shots in badminton can be described in terms of angular position, displacement, velocity or acceleration. The linear velocity of the rotating racket hitting the shuttle is directly proportional to the sum of both the angular velocity and the radius of rotation of the consecutive body segments in badminton strokes (Lee 1993). The timing of these consecutive rotational movements is important in relation to the hit of the racket with the shuttle (Gowitzke 1979). The linear momentum of the clearing arm and racket transfers to the shuttle according to the analogy of the force impulse and the change of linear momentum.

The purpose of the present preliminary research was to study the release velocity of the shuttle in maximal forehand overhead clear placing the shuttle on the opponents court in junior badminton players, to explain the produced angular and linear positions, velocities and accelerations in the racket, wrist, elbow and shoulder.

METHODS

Ten volunteer right-handed junior badminton players trained to perform maximal clears on the court. For motion analysis the subjects performed a minimum of five successful clears with the shuttle being served high to them. The fastest clear of every subject was selected for detailed analysis.

Anthropometric data for the subjects is shown in Table 1. Mean+S.D. of the subjects were as follows: age 12.2±3.3 years, height 1.562±0.137 m and mass 46.8± 11.0 kg. On average, they had 1.8±1.7 training years in badminton.

Each clear was recorded for 3-D analysis with NAC 400 (right side view) high speed video (100 fps) and Magnavox (back view) camcorder (60 fps). The optical axes of the cameras were perpendicular. The calibration scaling frame was rectangular with the dimensions of 2.0 m x 2.0 m x 3.0 m and it was filmed before and after measurements. An external synchronization unit was used to match video images between the cameras. Racket and shuttle were the same in all measurements. An APAS was used to process frame crabbing, digitizing, smoothing (DLT) and transformation. The mechanical model of trunk, head, upper arm, lower arm and hand (twelwe points) were combined with the racket (four points) and shuttle.

Table 1. Age, height, mass and training years of the subjects				
Subject	Age (year)	Height (m)	Mass (kg)	Training years
I.A.	8	1.375	37.2	< 1
K.K.	9	1.382	36.1	< 1
A.P.	10	1.501	34.2	< 1
P.A.	10	1.496	42.4	< 1
E.S.	11	1.575	45.5	> 1
P.T.	12	1.539	40.6	< 1
M.S.	14	1.750	65.0	< 1
K.I.	14	1.560	49.2	< 1
J.A.	15	1.670	53.6	> 4
J.H.	19	1.775	63.8	> 6

A descriptive analysis was performed on the differences in instantaneous joint positions, linear and rotational velocities.

RESULTS

The maximal release velocities of the shuttle were in the youngest novice subject (I.A.) and the most experienced oldest player (J.H.) 20.2 and 56.0 ms^{-1}, respectively. The maximal linear velocities in the youngest and the oldest subject were as follows: racket head 15.9 and 44.0 ms^{-1} , wrist 4.7 and 10.8 ms^{-1}, elbow 2.5 and 5.9 ms^{-1} and shoulder 1.6 and 2.9 ms^{-1}, respectively.

The instantaneous 3-D angular positions of the shoulder , elbow, wrist and racket during the hit with the shuttle in the most experienced player (J.H.) were 130, 159, 150 and 134 degree, respectively. The corresponding angles in the novice player were 119, 118, 168 and 138 degree, respectively.

The instantaneous angular velocities of the shoulder , elbow, wrist and racket during the hit with the shuttle in the most experienced player were 19.2, 7.0, 20.9 and 22.7 $rads^{-1}$, respectively. The corresponding angular velocities in the novice player were 1.4, 14.0, 0.3 and 6.3 $rads^{-1}$, respectively.

The timing pattern of the most experienced subject (J.H.) in badminton has been taken as an optimal timing pattern among these subjects in the clear (Figure 1). The timing pattern included 3-D velocities of the racket head, grip, wrist, elbow and shoulder.

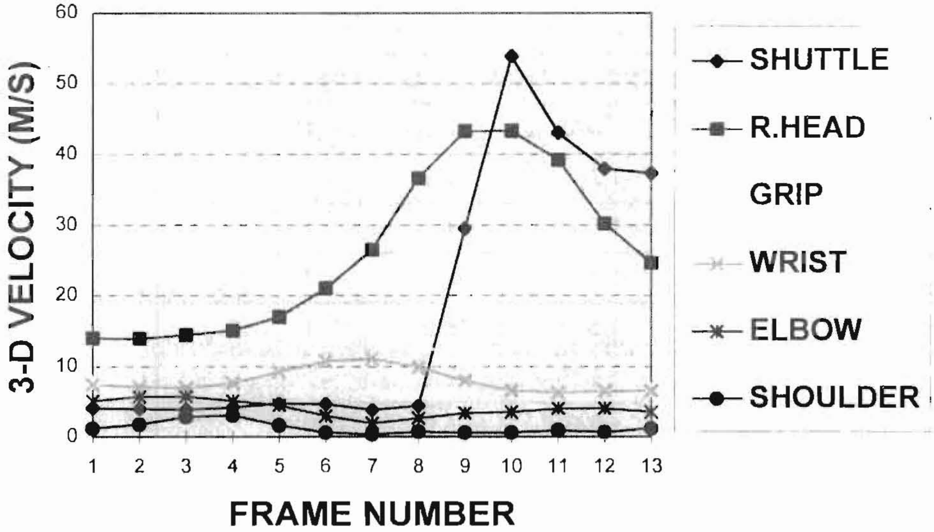

Figure 1. Timing pattern of the shuttle, racket head, grip, wrist, elbow and shoulder in 3-D velocities (hit in frame 9).

Figure 2 indicates the linear maximal 3-D velocities of the shuttle, racket head and selected joint axis in two less (I.A. and K.K.) and most (J.A. and J.H.) skilled junior badminton players.

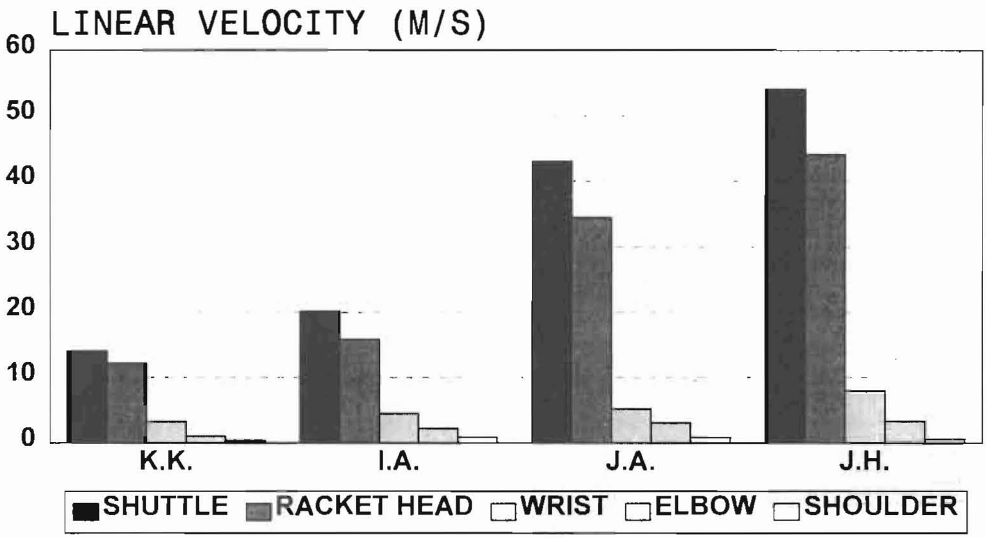

Figure 2. Linear maximal 3-D velocities of the shuttle, racket head and selected joint axis in two less (I.A. and K.K.) and most (J.A. and J.H.) skilled junior badminton players.

The ratio of the 3-D release velocity of the shuttle and the 3-D velocity of the racket head in the impact was in all subjects 1.15 - 1.27. On average the gain in the shuttle speed in the impact was higher in the most experienced players than in the novices.

The ratio of the 3-D velocity of the racket head and the 3-D velocity of the wrist in the impact phase was in all subjects 3.49 - 6.62. On average the extension of the wrist was relatively more powerful in the most experienced players than in the novices.

The ratio of the 3-D velocity of the wrist and the 3-D velocity of the elbow in the impact phase was in all subjects 1.67 - 3.14. On average the novices gained relatively more the velocity of the forearm in the impact phase with extension of the elbow than the most experienced players.

The ratio of the 3-D velocity of the elbow and the 3-D velocity of the shoulder in the impact phase was in all subjects 2.44 - 5.46. On average the extension of the shoulder was relatively more powerful in the most experienced players than in the novices.

CONCLUSION

It was observed that in comparison of the ratio of the 3-D velocities of the shuttle after the release and 3-D velocity of the shoulder during the impact with racket and shuttle, the gaining in the most experienced player was 88.5 and in the youngest novice 22.4. The largest differences were found in the function of the wrist in favour of the most experienced player.

In conclusion, the most experienced subject produced high speed for the shuttle through the kinematic chain of body segments with high angular and linear velocities through the impact of the shuttle and racket. The correct timing pattern of the consecutive body segments was also observed in the most experienced player. The lengths and high angular velocities of the body segments were advantageous features for players.

REFERENCES

Gowitzke, B.A. (1979) In: Science in Racquet Sports. J.Terauds (ed.) pp. 7-15. Del Mar, CA: Academic Publishers.

Lee, K.B. (1993) In: Biomechanics in Sports XI, J. Hamill, T.R. Derrick & E.H. Elliott (eds), pp. 239-242, University of Masschusetts, Amherst, MA.