BIOMECHANICAL ANALYSIS OF DIFFERENCES IN THE BADMINTON SMASH AND JUMP SMASH BETWEEN TAIWAN ELITE AND COLLEGIATE PLAYERS

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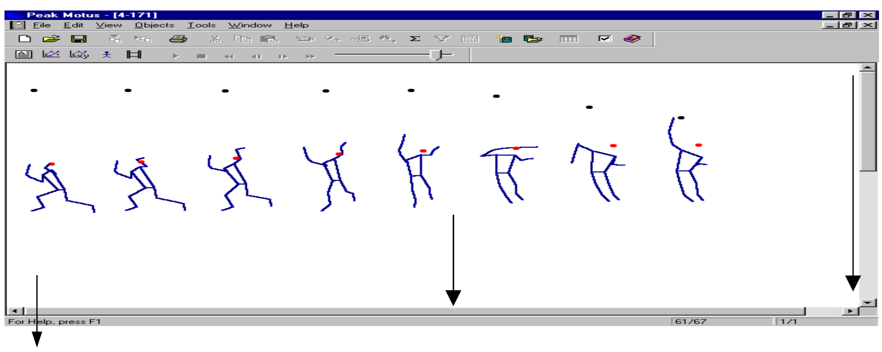
INTRODUCTION: Among the badminton skills, the forehand overhead smash is one of the typical techniques, and it is the most powerful stroke. It can be divided into two types, the stand smash (smash) and the jump smash. Previous studies related to badminton skills were conducted by several researchers, Poole, 1970; Adrian,1971; and Gowetzke, 1979; they used 2D models to describe the smash strokes. Tang, et al, 1994, who used a 3D model to measure the rotation of the forearm and the wrist, Tsai, et al., 1996 compared the smash and the jump smash of elite players with a 3D model. They were, however, only interested in one group of players. The purpose of this study was to compare the performance of the smash and jump smash respectively between two groups of the players (elite players and collegiate players).

METHODS AND PROCEDURES:

Subjects: Seven Taiwanese elite male right-handed badminton players (top 10 ranking in Taiwan, age 22 yrs, height 175 cm) and four collegiate players (age 21 yrs, height 168cm) served as the subjects of this study. The players were filmed using their own rackets to ensure that they would feel comfortable during their performance in the test.



Lowest CM
Preparation Phase
Contact CM
Contact Height

Figure 1. The Motion of the Jump Smash

Filming Procedures: In this study, we are interested in analyzing the motions from the phase of preparation in which the Center of Mass (CM) falls to the lowest position at the point of making contact with the shuttlecock. Fig.1 shows the range of motions from preparation phase to shuttle contact. Two Peak-Performance high speed video cameras operating at 120Hz (shutter speed is 1/2000) were used to record the kinematics 3-D data simultaneously. Fig. 2 gives a schematic drawing

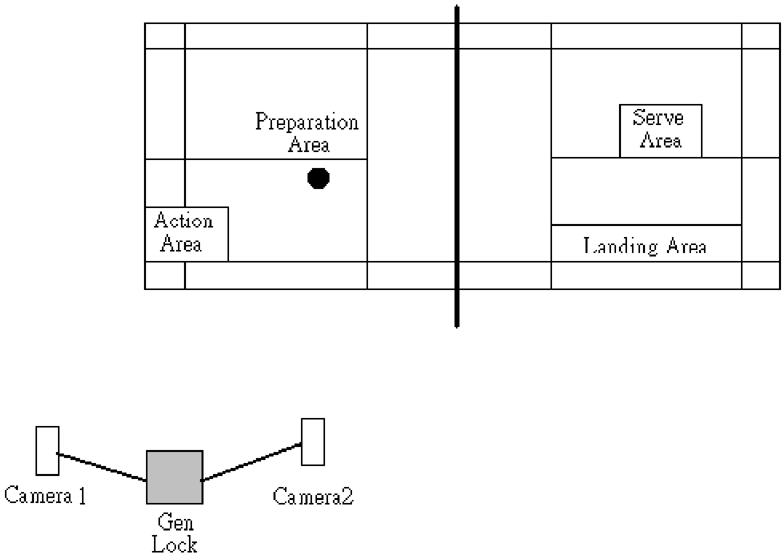


Figure 2. The Schematic of the Experimental Setup

of the experimental setup; the motions of the subjects and the reference frame were recorded in the motion area. After warming up, the subjects stood in the middle of the court to prepare and were ready to move backward into the motion area to receive the high serve from the service area. A successful trial was one in which the subject would hit the shuttle traveling down the line through the opposite court, and land in a position no more than 80 cm from the side line.

Analysis of the data: Nineteen 3D coordinates for the segment endpoints and racket were computed by using the Direct Linear Transformation (DLT) method. The variables we selected were the initial shuttle velocities of the smashes, the flying angle of the shuttlecock after contact, the time from the preparation position to shuttlecock contact, the height of contact, the lowest CM of the preparation phase, the height of the CM at contact, the relative distance of the contact to the CM, the angles and the angular velocities of the dominant upper arm. A t-test was used to compare and differentiate the two groups of players, the selected variables were tested at the 0.05 significance level.

RESULTS AND DISCUSSION: Figure 3 shows the vertical displacement of the CM between the smash and the jump smash. The jump smash involved a lower body CM and longer movement duration. There were no significant differences between the two groups of players in the variables that concerned the relative distance between the contact and the CM. Some of the results are shown in Table 1, in the smash stroke, the shuttle velocities of the elite players ranged from 55m/s to 70 m/s; the collegiate players ranged from 50m/s to 58 m/s. The elite players are significantly faster than the collegiate players. The elite players (55-75m/s) also performed significantly faster than college players (53-61m/s) in the jumping smash. Though the height of contact was insignificantly different between the two groups, the shuttle speed and the downward flying angle of the elite players were greater than those of the collegiate players in the jump smash. So the elite players achieved a higher shuttle velocity and sharper shuttle downward flying angle than did the collegiate players.

Figure. 3 The Vertical Displacement of C.M.
The Comparison Between Two Smashes

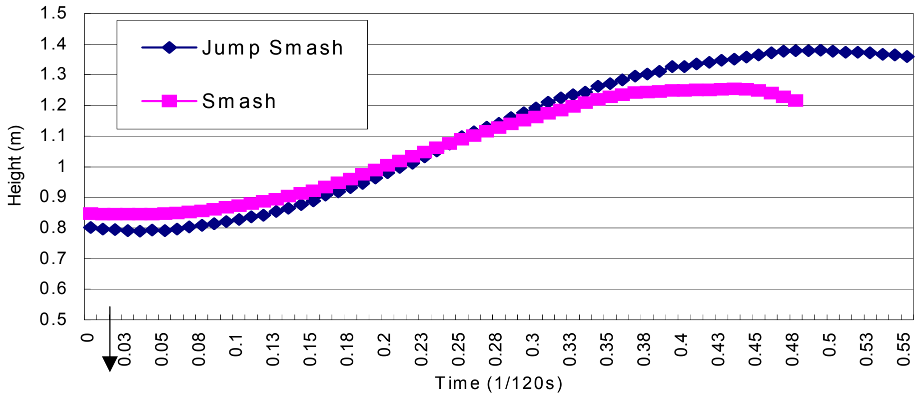


Table.1 Comparison Between the Two Groups in Smash and Jump Smash

Variables	Subjects	Smash Mean	Sig. Diff.	Jump Smash Mean	Sig. Diff.
Shuttle Speed	Elite	62.5		67.9	
(m/s)	College	54.2	*	56.5	*
Shuttle Flying Angle (deg)	Elite	-7.43		-13.47	
	College	-7.02		-8.69	*
Movement Time (sec)	Elite	0.354		0.511	
	College	0.371		0.577	*
Preparation Lowest C.M./Body	Elite	48.13		44.41	
Ht (%)	College	52.38	*	45.22	
Contact Height (m)	Elite	2.55		2.78	
	College	2.43		2.64	
Contact Height/Body Ht (%)	Elite	145		159	
	College	144		157	
Shoulder Angular	Elite	-479		-470	
Velocity (deg/sec)	College	-152	*	-475	
Elbow Angular	Elite	793		1035	
Velocity (deg/sec)	College	569		538	*
Wrist Angular	Elite	-1167		-1447	
Velocity (deg/sec)	College	-984		-996	

*p<.05

Therefore, in returning the smash strokes of elite players, these two factors are critical reasons making defense more difficult. The movement times from the preparation phase to the point of contact of the elite players were significantly shorter than the times of collegiate players. The distance from the lowest C.M. in the preparation phase to the CM at contact was not significantly different between the two groups, so the elite players achieved higher upward velocity than the collegiate players. This may be one of the reasons elite players achieved higher shuttle velocity in both smash strokes. The results showed that the elite players lowered their body more than the college players while performing smash strokes. But in performing the jump smash, there was the same height in the lowest C.M. When we observed upper arm movement from the side view, the angles of the upper arm at contact were the same between the two groups while performing the two strokes. The elbow angular velocity in the jump smash showed that the elite players were faster than the collegiate players. And the elite players were faster than the collegiate players in the shoulder angular velocity in the smash.

CONCLUSIONS: As the results of this study show, the elite players were more powerful than the college players in both the smash and the jump smash. The faster shuttle velocity of the jump smash may come from the elbow angular velocity. We also found that when the players performed the jump smash, the elite players produced a larger flying downward angle than the collegiate players. Though they both reached the same height in the jump smash, the elite players were more effective than the collegiate players. At the start of the smash movement, the elite players would lower their body to conserve energy and to release their power during the action portion. So the elite players who had a higher shuttle velocity were from the beginning of the movement.

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