KINEMATIC ANALYSIS OF THREE DIFFERENT BADMINTON BACKHAND OVERHEAD STROKES

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The purpose of this study was to analyze the performance of three different backhand overhead strokes (smash, clear and drop). In this study, we are interested in analyzing the phase of preparation position to the point of making contact with the shuttle. Two Redlake high-speed video cameras operating at 250Hz were simultaneously used to obtain 3-D data. A repeated one-way ANOVA and Pearson product moment correlation were used to test the selected variables at .05 significant levels. It was concluded that increasing the shoulder angle of drop and the wrist angular velocity of smash and clear will increase the shuttle velocity.

KEY WORDS: kinematics, badminton, backhand, smash, clear, drop.

INTRODUCTION: Overhead, underhand and sidestrokes are the three main categories of badminton strokes. However, the forehand and the backhand overhead strokes could be regarded as the fundamental to play badminton. Backhand overhead strokes could chiefly be categorized into drop, clear and smash techniques. Generally speaking, these three strokes share similar prepared positions. The kinematic variations during the stroke, on the contrary, could only be realized through scientific analyses. Biomechanical studies on badminton power strokes on forehand strokes (Gowitzke & Waddell, 1991; Tang *et al.* 1995), with fewer studies on backhand strokes. The purpose of this study was to use 3D videography to analyze the kinematic variables of badminton backhand strokes. The data provided by this study can be a useful information for coaches and players.

METHODS: Eight male subjects (age = 18.8±0.9 yrs, height = 174.8±3.5 cm weight =66.9±4.5 kg) were studied. Figure 1 shows the model and kinematic variables analyzed, and figure 2 shows the schematic layout of the experimental setup. Two Redlake high-speed video cameras operating at 250Hz were used to record the action of the players. The movements of the players were videotaped in the action area where the reference frame was located. Twenty-one 3-D coordinates for the segment endpoints and racket were computed by the Direct Linear Transformation Method (DLT). The raw data were smoothed by using the cubic spline function provided by the Peak Motus system. A repeated one-way ANOVA was used to test the selected variables at .05 significant levels. If a significant difference was found, a Tukey's post hoc test was done to decide the difference among three strokes. A Person product moment correction was used to test the selected variables with the shuttle velocity. The effect size and power are also reported in the tables. In this study, we are interested in analyzing from the phase of preparation where the Center of gravity (C.G.) goes down to the lowest position, the point of making contact with the shuttle. During the phase of position preparation to the point of making contact with shuttlecock, the variables we selected were the initial velocities, the initial flying angle of the shuttle, the sagittal plane angle and sagittal plane angular velocities of shoulder, elbow and wrist in contact.

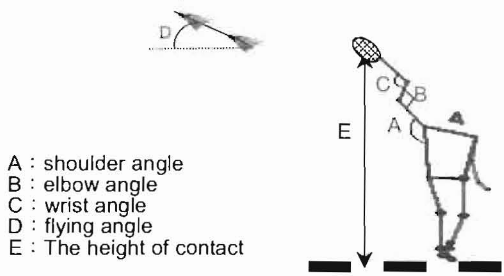

Figure 1. Description of kinematic variable definition.

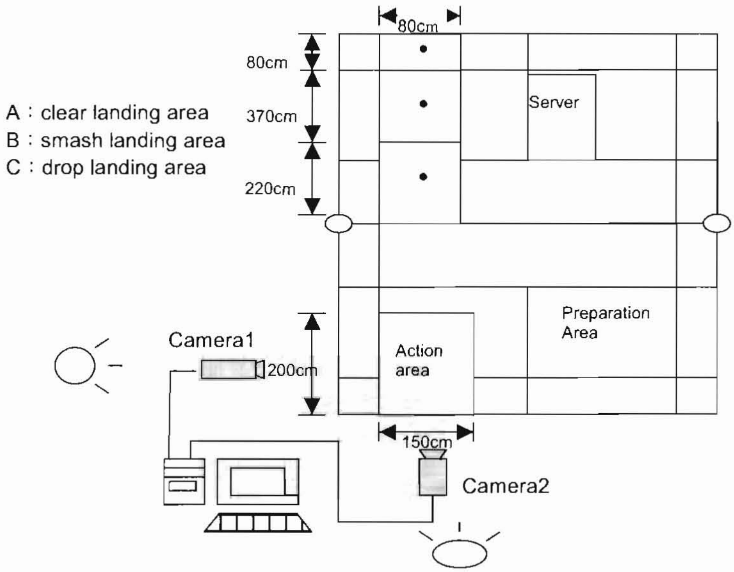

Figure 2. Schematic layout of experimental setup.

RESULTS AND DISCUSSION:

Table 1. Selected variables of the drop, clear and smash at impact.

		Mean	SD	drop	clear	smash	effect	power
Shuttle velocity (m/s)	drop	25.2	4.2	–	*	*	2.70	0.99
	clear	53.0	3.2	–	–			
	smash	52.1	6.7	–	–	–		
Flying angle (deg)	drop	4.9	4.2	–	*		1.69	0.99
	clear	22.1	5.2	–	–	*		
	smash	-4.0	3.7	–	–	–		
Contact height (cm)	drop	211.2	12.3	–	*		0.73	0.80
	clear	231.7	10.5	–	–			
	smash	224.2	7.8	–	–	–		
Racket angle (deg)	drop	90.8	5.3	–	*	*	2.46	0.99
	clear	104.8	4.6	–	–	*		
	smash	81.0	4.7	–	–	–		

Notes: Statistical significant different among drop, clear and smash.
*p<.05

Table 1 shows that the shuttle speed of backhand drop shot is considerable slower than the clear and smash shot. Comparing the results to Tsai *et al* (1997) on a forehand stroke, it is indicated that the backhand clear shot (53.0m/s) was faster than the forehand clear shot (47.5m/s). The backhand drop shot (25.2m/s) has a similar shuttle velocity to the forehand drop shot (25.0m/s). The backhand smash shot (52.1m/s) was slower than forehand smash shot (68.16m/s). The drop and clear shots have positive shuttle flying angles (upwards) while smash shot has a negative angle (downwards)(Table 1). By observing the video image, it became evident that the shuttle in the drop shot travelled upwards for a shorter distance before it progressed downwards. This contradicts the coaches and players opinion that the shuttle goes downwards after the impact in the drop shot. On account of the height of the shuttle contact, the clear shot has a significant higher contact point than the drop shot. In addition, the clear and drop shots have upward racket angles while the smash shot has a downward angle. There are significant differences among drop, clear and smash in relation to racket angles.

Table 2. The angle and angular velocities (A.V.) of the upper limb of the drop, clear and smash at impact.

		Mean	SD	drop	clear	smash	effect	power	R
Shoulder angle (deg)	drop	207.6	57.6	–					0.75*
	clear	176.5	25.5	–	–				
	smash	192.7	20.7	–	–	–			
Elbow angle (deg)	drop	150.1	23.2	–	*	*	0.76	0.84	
	clear	168.7	10.1	–	–				
	smash	169.5	10.8	–	–	–			
Wrist angle (deg)	drop	176.0	32.8	–					
	clear	178.3	13.5	–	–				
	smash	164.5	11.2	–	–	–			
Shoulder A.V. (deg/s)	drop	-383.3	270.8	–					
	clear	-184.1	159.6	–	–				
	smash	-271.7	122.6	–	–	–			
Elbow A.V. (deg/s)	drop	862.0	680.5	–					
	clear	524.0	488.8	–	–				
	smash	745.7	665.6	–	–	–			
Wrist A.V. (deg/s)	drop	-591.7	480.2	–		*	0.71	0.80	
	clear	-1131.1	569.0	–	–				-0.80*
	smash	-1497.4	509.2	–	–	–			-0.72*

Notes: Statistical significant different among drop, clear and smash.
*$p<.05$

Table 2 indicated that the drop shot has a significant smaller sagittal plane elbow angle than the clear and smash shot. The drop shot has a smaller sagittal plane wrist angular velocity than the smash shot when players hit the shuttle. A significant positive correlation was found between the sagittal plane shoulder angle and the drop shuttle velocity. A significant positive correlation was also found between the sagittal plane wrist angular velocities and the clear and smash shuttle velocity.

CONCLUSION: The purpose of this study was to kinematically analyze three badminton backhand overhead strokes. It was concluded that the increased wrist angular velocity of smash and clear improves the shuttle velocity. It was concluded that increasing the shoulder angle of drop and the wrist angular velocity of smash and clear will increase the shuttle velocity.

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