HOP TIMING OF SPLIT STEP AND KINETICS ANALYSIS OF LOWER EXTREMITIES IN BADMINTON START FOOTWORK

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The purpose of this study was to compare the split timing, and lower extremity kinetics of badminton players during push-off steps in six directions. Eight collegiate elite male badminton players received the random shot from an opponent in one of six directions. Result: Hop timing was 0.014-0.037 sec after the opponent struck the shuttlecock. The leg that was opposite the movement direction showed significantly greater lower extremity horizontal push-off force than the other leg did. Conclusion: The hop timing of split step simultaneous with the opponent striking the shuttlecock. The leg opposite the movement direction was the main push leg. When lower extremities exhibit the correct pushing direction and reach the peak push off force within 0.3 sec after the opponent strikes the shuttlecock, players should have more effective return in badminton .

KEYWORDS: badminton, push off , footwork..

INTRODUCTION: The spilt step is commonly used during a tennis serve return. This step can increase footwork start velocity (Nieminen, Piirainen, Salmi, and Vesa Linnamo, 2014) through a stretch-shortening cycle (SSC) in the lower extremity muscles (Komi, 2008). Previous related studies have provided information useful to competition such as the proper split step timing and which leg should be the primary push-off leg to start footwork. In badminton, the split step is crucial footwork skill (Grice,2008). However, recent studies on badminton footwork have focused on the lunge (Kuntze, Mansfield and Sellers; 2010), injuries (Besier, Lloyd, Ackland and Cochrane; 2001) and electromyography analyses of lower extremities (Tsai, Yang, Lin, Hung and Chang; 2006). Thus, information on the badminton split step initiation insufficient. This study investigated spilt step timing and which leg is the primary push-off leg after the split step for six different directions.

METHOD: Eight collegiate elite male badminton players participated in this study (height: 173 ± 3.6 cm; weight: 68.1 ± 4.67 kg; age: 21 ± 3 years). The participants hit a deep clear serve behind the force plate to the opponent who stood in the opposite rear court, and then the participants prepared to receive the returned attacks from the opponent while standing with each leg on separate force plate. After the participants served, the opponent struck the shuttlecock randomly with a drop, smash, or clear. Placements of the drop, smash and clear

were either to the left or right of the front court, midcourt and rear court (Figure 1). Participants were required to use assigned footwork to return the shuttlecock from one of these six locations. We collected information from three successful trials for each location and analyzed the fastest one. High speed cameras (300Hz) were used to record the hit timing of the opponent. Marker data were captured using eight infrared cameras (Motion Capture System, T20-S, UK, capture frequency: 300Hz) and Nexus 1.8 software. Visual 3D software was used to calculate kinematic and kinetic data. The ground reaction force was recorded using two force plates (Kistler 9287 and AMIT 5507; record frequency: 1500Hz). The analyzed movement range began when the participant served the shuttlecock and ended when his first foot left the force plate The timing data of the six directions of movement were compared through Friedman's ranked two-way analysis of variance. The ground reaction force between the right and left foot were compared through the nonparametric Wilcoxon signed-rank test. The level of significance were set as $\alpha = .05$.

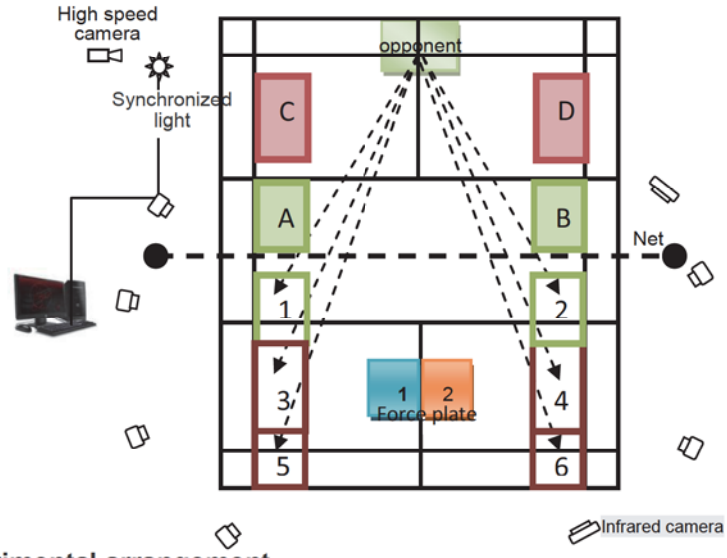

Figure 1: Experimental arrangement

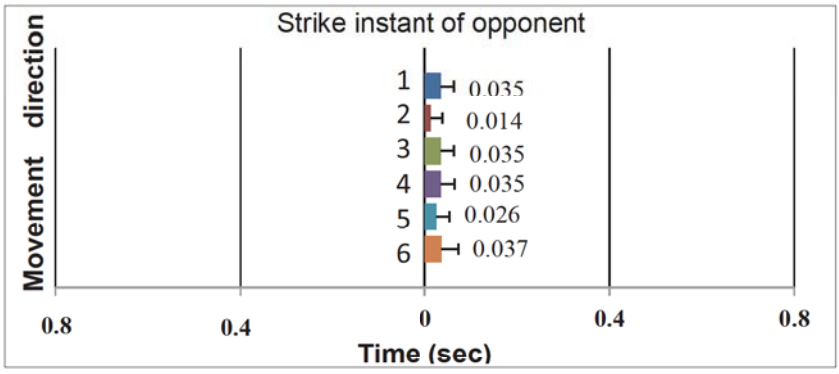

Figure 2: Timing of the slight hop before the start step

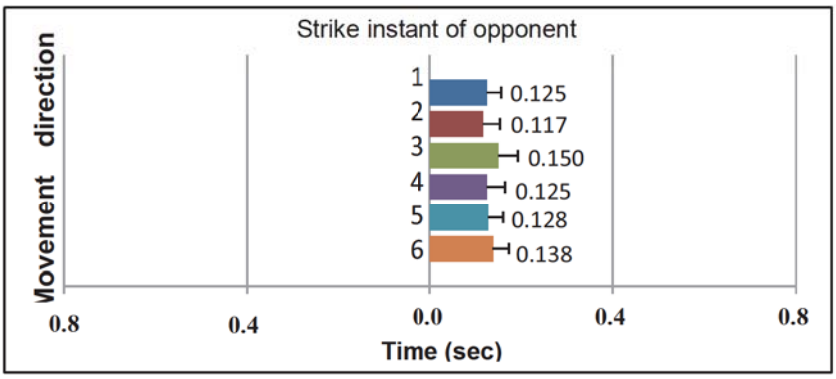

Figure 3: Timing of the slight hop landing before the start step

Table 1

Comparison of the feet's peak horizontal reaction force and timing

parameter	Movement direction	Left foot (N=8) mean ± deviation	Right foot (N=8) mean ± deviation	*P*
Peak horizontal reaction force appear timing (Unit =sec)	Left front	0.371 ± 0.103	0.283 ± 0.035	0.063
	Right front	0.288 ± 0.032	0.372 ± 0.074	0.036*
	Left	0.352 ± 0.098	0.279 ± 0.029	0.063
	Right	0.273 ± 0.021	0.348 ± 0.047	0.028*
	Left rear	0.393 ± 0.032	0.295 ± 0.033	0.012
Front- rear direction (Unit = % Body Weight)	Left front	-0.144 ± 0.199	-0.479 ± 0.172	0.01 *
	Right front	-0.419 ± 0.213	-0.308 ± 0.211	0.58
	Left	0.066 ± 0.197	-0.135 ± 0.354	0.48
	Right	0.129 ± 0.152	0.015 ± 0.120	0.07
	Left rear	0.340 ± 0.401	0.279 ± 0.384	0.67
	Right rear	0.162 ± 0.137	0.468 ± 0.242	0.04 *
Left-right direction (Unit = % Body Weight)	Left front	-0.038 ± 0.126	-1.161 ± 0.210	0.012 *
	Right front	0.916 ± 0.249	-0.028 ± 0.126	0.012 *
	Left	0.028 ± 0.121	-1.306 ± 0.261	0.012 *
	Right	1.199 ± 0.238	-0.043 ± 0.191	0.012 *
	Left rear	0.167 ± 0.189	-1.109 ± 0.179	0.012 *
	Right rear	0.847 ± 0.159	-0.169 ± 0.200	0.012 *

* $p < .05$; + expresses that the horizontal force direction was rear or right ; − expresses that the horizontal force direction was front or left .

RESULTS: The hop and landing timings of the split steps in the six movement directions were not significantly different (Figure 2, 3). Hop timing occurred approximately 0.014-0.037 sec after the opponent struck the shuttlecock. Landing timing occurred approximately 0.117-0.138 sec after the opponent struck the shuttlecock. Table1 displays the peak horizontal reaction force of the feet. Regarding the front -rear component, there was significant difference

between the two feet in the left front and right rear movement directions. Regarding the left -right component, there was significant difference between the two feet for all the movement directions. The foot opposite the movement direction had a greater reaction force than did the one homolateral to the movement direction.

DISCUSSION: All six split step movement directions were initiated after the opponent contacted the shuttlecock. Thus, the participants didn't differentiate the placement or prepare to move before the shuttlecock was struck. For the landing timing of the spilt step, the result in this study (approximately 0.15 sec) was slightly shorter than what was indicated by a related tennis study (Nieminen et al., 2014) as the ideal landing timing (0.18-0.2 sec). The difference between the two studies may be caused by the faster tempo of badminton competition than of tennis, causing the study participants to land earlier and prepare for their next movement. Although badminton requires an earlier landing timing, there was a short delay between stretch and shortening (less than 0.5 sec) when the peak ground reaction force (GRF) appeared. Thus, the timing of landing for start footwork in badminton still had an effective SSC function (Komi, 2008). The results in Table 1 indicate that the participants primarily used the foot opposite the movement direction to push off, and the direction of the GRF was consistent with the movement direction. The participants determined the placement of the shuttlecock approximately 0.3 sec after the opponent struck the shuttlecock.

CONCLUSION: A split step with the hop simultaneous to the opponent striking the shuttlecock and the landing approximately 0.18 sec after could have yield both an ideal judgment for the placement of the shuttlecock and an effective use of an SSC. To return the shuttlecock successfully, badminton players must judge the placement of the shuttlecock and push off correctly in less than 0.3 sec after the shuttlecock is struck.

REFERENCES:

Komi, P. V. (2008). *Strength and Power in sport (2nd ed)*. Champaign, IL: Wiely-Blackwell

Nieminen, M. J. J., Piirainen, J. M., Salmi, J. A. & Vesa Linnamo, V. (2014). Effects of neuromuscular function and split step on reaction speed in simulated tennis response. *European Journal of Sport Science,* 14(4), 318-326.

Grice, T. (2008). *Badminton Steps to Success (2th ed)*. Champaign, IL: Human Kinetics.

Kuntze, G. Mansfield, N. & Sellers, W. (2010). A biomechanical analysis of common lunge tasks in badminton. *Journal of Sports Sciences,* 28(2), 183-191.

Besier, T. F., Lloyd, D. G., Ackland. T. R., & Cochrane J. L. (2001). Anticipatory effects on knee joint loading during running and cutting maneuvers. *Medicine & Science in Sports & Exercise*, 33(7), 1176-1181.

Tsai, C.L., Yang, M. S., Lin, M. S., Hung, K.. S., & Chang, S. S. (2006). The EMG activity of the lower extremities in badminton smash stroke. *Journal of biomechanics, 39*, 562.