BIOMECHANICAL ANALYSIS OF BADMINTON DIFFERENT FORWARD STEPS

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The purpose of this study was to compare the biomechanical variables between 2-step and 3-step forward steps in badminton. Eight collegiate elite male badminton players participated in this study. Eight Vicon T-20 cameras (300 Hz) were used to record the 3D kinematics data and a Kistler force plate (1500 Hz) was used to collect the GRF data of the last steps. A Wilcoxon matched-pairs signed-rank nonparametric statistical test was conducted to compare the differences between two kinds of forward step movements. The results showed that the movement time for 3-step movement was significantly faster than 2-step. We recommend that the badminton players should practice 3-step forward footwork technique. The additional strength and power training for lower limbs should be carried out for the footwork training.

KEY WORDS: footwork, kinematics, kinetics, lob

INTRODUCTION: Badminton is a popular racquet sport played by the opposing players who take positions on opposite court divided by a net. Badminton is a sport that combine strength, power, agile and endurance capacities. The racket techniques and the footwork are the most important issues in the badminton game. Most of the previous studies focused on the upper limb movement analyses. There were a few badminton studies that aimed on the injury of the badminton such as (Fahlström, Björnstig & Lorentzon, 1998, Jørgensen & Winge, 1990) they found that the most injury occured in the lower extremities. Lees & Hurley (1994) found that the inexperienced players generated more force than the experienced players. Kuntze, Mansfield & Sellers (2010) aimed the three different techniques of the badminton footwork and found that the step-in lunge might be beneficial for reducing the muscular demands of lunge recovery. The badminton footwork could be mainly divided into three categories: paths 1 & 2 are the net play steps or the forward steps, paths 3 & 4 are the side steps, paths 5 & 6 are the backward steps (see figure 1). The defence forward footwork can be divided into two patterns, 2-steps and 3-steps (figure 2). The purpose of this study was to compare the kinematics and kinetics data between 2-steps and 3-steps in path 1 when the players were performed defence forehand lob techniques.

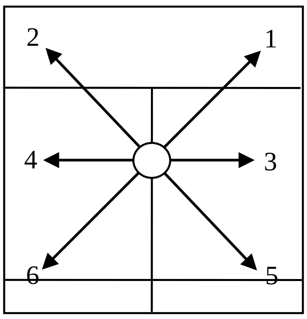

Figure 1: All-court steps diagram

Figure 2: Forward steps patterns, A：2-step, B：3-step

METHODS: Eight male collegiate badminton first class players served as the participants. Eight Vicon infrared high speed T-20 cameras (Vicon, Oxford, UK, 300Hz) were used to record the kinematics data of different footwork. One Kistler 9287 force plate (1500Hz) was synchronized to collect the kinetics data of the last forward step. The experimental setup of the study was as in the figure 3. The venue was a formal badminton singles play court. The distance from preparation area to the net is 370cm. The distance from the end of force plate to the net is 138cm, while the distance from the side of force plate to the sideline was 50cm. The opposite performer hit the drop shot back into 60cm inside from side line. When the experiment start, the participant served the shuttle clear shot to the opposite rear court and the participant stay in the preparation area ready to move forward. One badminton player stood on the rear court to perform the drop shot back to the right side of the participant's as in the figure 3. The participants moved to the right front with 2-step and 3-step in counter balance order to return the drop shot with a lob into shuttle landing area of opposite rear court. The kinematics and the inverse dynamics data of the last step was computer by the Vicon Nexus 1.8 and Visual 3D software. The foot contact time variables and the 3D Ground Reaction Force (GRF) were measured by a Kistler force plate. The time parameters were as followed: Step forward duration time was the time from the start while the lowest centre of gravity of participant to move to the moment that the right heel contact at the force plate. The perform time, from the start to move to hit the shuttlecock for returning drop shot. Landing duration time, from the last step contacted the force plate to move the foot off the force plate. Total time: from the lowest centre of gravity at the start of participant moved forward and back to the moment that the right foot was totally off the force plate. The kinematics and the kinetics data were analyzed by the Wilcoxon matched-pairs signed-rank nonparametric statistical test with statistical level set at α =.05, via statistical software SPSS 20.0 for Windows.

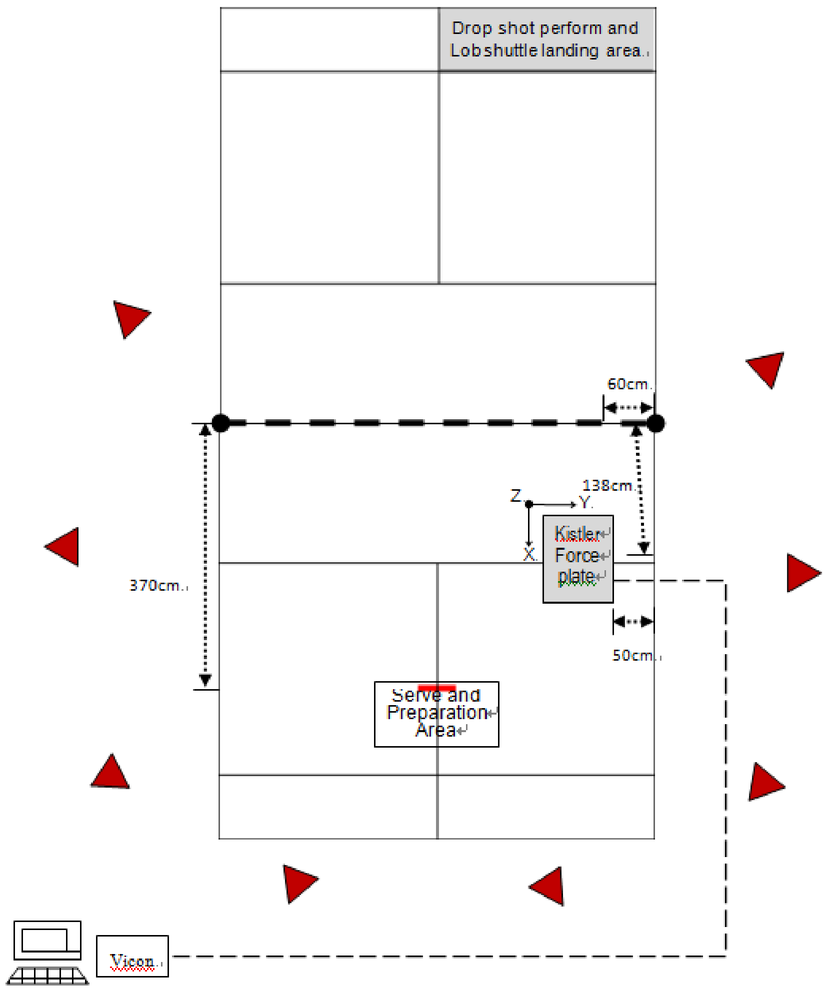

Figure 3: The experimental setup of the badminton forward steps

RESULTS: Table 1 showed the time parameter of the two type step movements. Table 2 showed the peak GRF in forward & backward, lateral & medial, and vertical directions. Table 3 showed the peak joint torque while the right foot contact the force plate of the two type step movements..

Table 1
Comparison of 2-step and 3-step time parameters

Variable	Motions	Average	Standard Variation	Wilcoxon
Step forward duration time(sec)	2-step	1.18	0.12	-2.100*
	3-step	1.06	0.08	
Perform time (sec)	2-step	1.24	0.14	-2.100*
	3-step	1.13	0.08	
Landing duration time (sec)	2-step	0.70	0.10	-1.687
	3-step	0.74	0.12	
Total Time (sec)	2-step	1.94	0.20	-1.612
	3-step	1.80	0.15	

*p<.05

Table 2
The comparison of maximum ground reaction of 2-step and 3-step

Variable	Motions	Average	Standard Variation	Wilcoxon
Backward GRF (%BW)	2-step	1.04	0.17	-0.911
	3-step	1.11	0.19	
Medial GRF (%BW)	2-step	-0.78	0.07	-0.631
	3-step	-0.81	0.11	
Vertical GRF of 1st Peak %BW)	2-step	1.85	0.19	-2.028*
	3-step	2.10	0.41	
Vertical GRF of 2nd Peak (%BW)	2-step	2.00	0.15	-0.140
	3-step	2.01	0.21	

*p<.05

Table 3
The comparison of maximum joint torque between 2-step and 3-step

Variable	Motions	Average (N-m/kg)	Standard Variation	Wilcoxon
Hip Joint (Flex. +, Ext. -)	2-step	-3.60	1.16	-0.840
	3-step	-4.19	1.11	
Hip Joint (Add +, Abd -)	2-step	3.06	0.99	-2.240*
	3-step	4.20	1.40	
Knee Joint (Exten.+, Flex. -)	2-step	2.33	0.47	-0.840
	3-step	2.42	0.47	
Knee Joint (Add +, Abd -)	2-step	-1.12	0.32	-0.631
	3-step	-1.19	0.45	
Ankle Joint (Dor. +, Plan F.-)	2-step	-1.21	0.24	-0.491
	3-step	-1.28	0.38	
Ankle Joint (Inver. + Ever. -)	2-step	0.17	0.13	-0.421
	3-step	0.17	0.09	

*p<.05

DISCUSSION: Table 1 showed the time parameter of the two type forward step movements. There were significant differences between the 2-step and 3-step forward footwork movements in step forward duration time and perform time. We found that both of the step forward duration time and the perform time that the 3-step movement time was faster than the 2-step. There were no significant differences in the landing duration and total movement time between 2-step and 3-step. There were no significant differences between 2-step and 3-step in the angular variables. In table 2, we found that there was significant difference between 2-step and 3-step footwork in the first peak force at the vertical direction. There were no significant differences between 2 step and 3 step badminton forward movement in the forward and backward force and the lateral and medial force. The 1st peak GRF of the 3-step was significant greater than 2-step footwork. That might come from the greater velocity of the 3-step footwork movement. In table 3 we found that there was a greater hip adduction torque in 3-step than 2-step footwork movement during the landing period of the last step.

CONCLUSION: The results showed that the 3-step forward duration time and perform time is significantly faster than 2-step footwork movement. So the 3-step forward badminton footwork seemed to be a better technique to perform net play defence shots. In the period of supporting phase of two style forward steps, there was a greater hip adduction torque in 3-step than 2-step footwork movement. That might come from the faster movement of the 3-step footwork. We recommend that the badminton players should practice 3-step forward footwork technique and the additional strength and power training for lower limbs should be carried out for the footwork training.

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