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THE KINEMATICS ANALYSIS OF TABLE TENNIS FOREHAND AND BACKHAND DRIVES

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SUMMARY
The purpose of this study was to explore the kinematics analysis in the table tennis forehand and backhand drives. The VICON Motion Capture systems (250 Hz) were used to collect and calculate the kinematics data of six elite collegiate table tennis players in Taiwan. The variables were compared by the Wilcoxon matched-pairs signed-rank nonparametric statistical test, the significant level was at α =.05. The results showed though the forehand drives were more offensive, the backhand drive exerted less movement time that could increase the success rate. The players should do the similar practice not only on the forehand but also on the backhand drives.

INTRODUCTION
Both of the forehand and backhand drives are the main offensive techniques of the table tennis. The comparison between the forehand and backhand drives is a great topic that the table tennis players are interested. Previous studies of table tennis focused on the motions of forehand strokes. This includes the studies as Kasai & Mori (1992) described the movement appearance of the forehand table tennis drives. Yoshida, Sugiyama & Murakoshi (2004) observed that the duration time from the ball rebound on the table to the contact point of the forehand drives were about 0.2 seconds. Tsai, et al (2010) found the table tennis players performed the forehand drive both to increase the racket tilt angle in advance and to raise the racket path angle during the upswing phase. The purposes of this study were to compare the kinematics variables between the forehand and the backhand drives when the players were receiving the topspin and the backspin table tennis services.

METHODS
Six male table tennis elite collegiate players in Taiwan (21.0 ± 4.69 yr old, 173.5 ± 4.59 cm, 67.0 ± 5.80 kg) served as the participants. Figure 1 shows the schematic drawing of the experimental setup. The server fed the topspin and the backspin balls into the circles (diameter 50cm) on the action end corners for the participants'. The participants returned straight and diagonal paths with forehand and backhand drives into the 50×50cm squares at right end in random order. The 3D kinematics data were recorded by using ten VICON Motion Capture systems MX13+ (250 Hz) and the VICON Nexus 1.52 software was used to calculate the kinematical variables. The kinematics data were tested between the forehand and backhand drives by Wilcoxon matched-paired signed rank nonparametric statistical test. All the variables were tested by SPSS 19.0 statistical software at a .05 significant level.

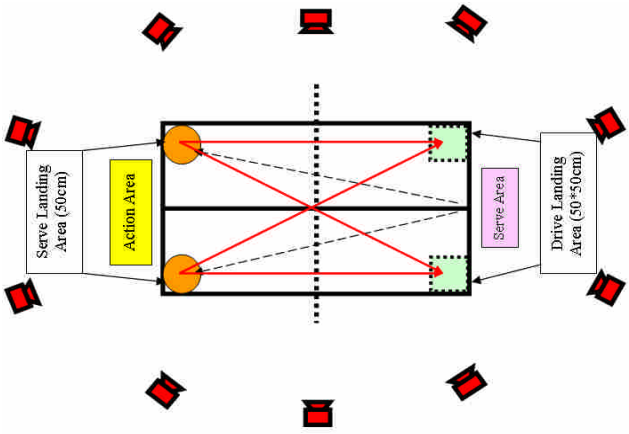

Figure 1: The Schematic of the Experimental Setup

RESULTS AND DISCUSSION
The results are shown as in the table 1. The table tennis ball initial velocity and racket head velocity of forehand drives were faster than the backhand drives. The upward swing duration time and the total movement time of the forehand drives were longer than the backhand drives. The racket displacements of the forehand drive were significantly greater than the backhand drives. There were no significant difference in the racket tilt contact angle between forehand and backhand drives except returned the backspin diagonal drives. The Center of Gravity (COG) heights at contact of the forehand drives were significant superior than the backhand drives'. The COG peak velocities during the forehand drive movements were faster than the COG velocities of the backhand drives. We found that the table tennis forehand drive was more offensive than the backhand drive might combine with the strategies of increasing COG velocity, racket displacement and the swing upward duration time. On the contrary, the players who used backhand drives still had the advantages. The backhand drive might perform offensively with less COG movement, less racket swing and less time interval. Those points made the backhand drive as the same important as the forehand drive.

CONCLUSIONS

In this study, we applied 3D methods to compare the kinematics variables between forehand and backhand table tennis drives while received the topspin and the backspin serves. We found that there were significant differences between forehand and backhand drives in the following variables, the movement duration time, the initial velocity of the table tennis ball, the peak racket swing velocity, the velocity of COG, racket upswing displacement and the height of COG at the contact point, the forehand were greater than the backhand drives. There were greater racket tilt contact angle of forehand diagonal drive when returning backspin serves. Though the forehand drives were more offensive, the backhand drive exerted less movement duration time that still could increase the offensive success rate. We recommend that the players should do the similar training quantity and quality both in the forehand and backhand drives.

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Table 1: The Kinematics Variables Comparison between the Forehand and the Backhand Drives

Variables \ Techniques	Serve Spins & Drive Paths	Forehand Drive	Backhand Drive	Wilcoxon test
Ball Initial Velocity (m/s)	Topspin Straight Line	17.905 ± 1.609	13.546 ± 1.791	.028*
	Topspin Diagonal Line	18.711 ± 1.236	15.244 ± 0.773	.028*
	Backspin Straight Line	15.857 ± 2.031	14.202 ± 1.203	.249
	Backspin Diagonal Line	17.428 ± 1.057	14.288 ± 0.815	.028*
Racket Head Peak Velocity (m/s)	Topspin Straight Line	17.183 ± 0.726	14.623 ± 1.453	.028*
	Topspin Diagonal Line	17.395 ± 0.592	15.326 ± 1.290	.046*
	Backspin Straight Line	17.808 ± 0.849	15.958 ± 2.060	.046*
	Backspin Diagonal Line	18.086 ± 0.724	17.542 ± 0.385	.116
Total Action Duration Time (sec)	Topspin Straight Line	0.910 ± 0.197	0.781 ± 0.204	.093
	Topspin Diagonal Line	0.914 ± 0.207	0.751 ± 0.148	.025*
	Backspin Straight Line	1.008 ± 0.282	0.826 ± 0.102	.028*
	Backspin Diagonal Line	0.944 ± 0.202	0.841 ± 0.218	.263
Swing Upward Duration Time (sec)	Topspin Straight Line	0.162 ± 0.050	0.111 ± 0.010	.058
	Topspin Diagonal Line	0.177 ± 0.045	0.100 ± 0.011	.046*
	Backspin Straight Line	0.176 ± 0.054	0.102 ± 0.008	.046*
	Backspin Diagonal Line	0.178 ± 0.049	0.101 ± 0.012	.046*
Downward Swing Racket Displacement (m)	Topspin Straight Line	1.181 ± 0.076	0.589 ± 0.067	.028*
	Topspin Diagonal Line	1.166 ± 0.123	0.574 ± 0.085	.028*
	Backspin Straight Line	1.145 ± 0.135	0.669 ± 0.132	.028*
	Backspin Diagonal Line	1.171 ± 0.095	0.711 ± 0.124	.028*
Upward Swing Racket Displacement (m)	Topspin Straight Line	1.129 ± 0.141	0.599 ± 0.072	.028*
	Topspin Diagonal Line	1.151 ± 0.164	0.615 ± 0.058	.028*
	Backspin Straight Line	1.200 ± 0.165	0.631 ± 0.087	.028*
	Backspin Diagonal Line	1.201 ± 0.198	0.659 ± 0.092	.028*
Racket Tilt Angle At Contact (deg)	Topspin Straight Line	55.27 ± 3.22	52.74 ± 1.23	.345.
	Topspin Diagonal Line	56.42 ± 2.48	54.65 ± 2.94	.463
	Backspin Straight Line	63.48 ± 6.65	63.80 ± 3.25	.917
	Backspin Diagonal Line	65.49 ± 4.50	61.58 ± 4.71	.046*
COG Height at Contact (Body Height %)	Topspin Straight Line	49.5 ± 0.8%	46.6 ± 1.3%	.046*
	Topspin Diagonal Line	49.0 ± 1.2%	46.3 ± 1.5%	.046*
	Backspin Straight Line	48.7 ± 1.1%	44.7 ± 1.5%	.028*
	Backspin Diagonal Line	48.8 ± 1.4%	44.9 ± 1.2%	.046*
Peak COG Velocity (m/s)	Topspin Straight Line	1.250 ± 0.227	0.572 ± 0.098	.028*
	Topspin Diagonal Line	1.267 ± 0.242	0.552 ± 0.045	.028*
	Backspin Straight Line	1.341 ± 0.232	0.701 ± 0.191	.028*
	Backspin Diagonal Line	1.332 ± 0.284	0.658 ± 0.094	.028*

*$p < .05$