EFFECTS OF 1 & 2 HANDED TENNIS BACKHAND ON TRUNK ROTATION

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This study examined hitting a 1 & 2 hand backhands with moderate and maximal power on the shoulder, hip, and trunk rotations during a tennis groundstroke by collegiate male and female tennis players. Video images from 2 views at 60Hz were collected as players hit backhand strokes with a ball launched from a serving stand. Each subject hit 10 trials with moderate and maximal power using 1 & 2 hand backhands to a 2x2m target area. Average ball velocities for stroke conditions were determined and 2 trials closest to the condition average velocity were analyzed with Ariel APAS. ANOVA on the shoulder rotations found significant hand and power factors, where maximal power and 2 hand backhands used more shoulder motion. The 2 hand backhand produced greater hip rotation and the female subjects used more trunk rotation with a 2 handed backhand.

KEY WORDS: Tennis backhand technique, Trunk rotation

INTRODUCTION: Low back pain has been reported to occur in as many as 80-90% of tennis players (Pluim & Safran, 2004). This study investigated factors of the backhand ground stroke that may contribute to low back pain and it examined the effects of gender, striking technique, and power level on collegiate tennis players performing backhand strokes on resultant trunk rotation. The down line backhand was reported by Elliott & Reid (2002) to produce the greatest amount of shoulder and hip rotation using 1 and 1 hand backhands. Therefore by investigating the range of motion of the body alignments utilized in hitting 1 & 2 hand backhand tennis strokes at different power levels this may provide insight into potential contributory factors of low back pain of male and female tennis players

METHODS: Five players volunteered each from the Indiana State University Men's & Women's Tennis teams read and signed an informed consent. Each subject performed 10 tennis backhand strokes using either 1 or 2 hands, and hit an incoming launched ball with moderate or maximal hitting power from the ad court down the line to a 2m x 2m area located in the back corner of the court. The subjects had 25 data points marked and each stroke was recorded at 60 Hz with a 1/1500s shutter speed using 2 Panasonic PV-GS65 video cameras provided a side view from 5m away and the other camera provided a left rear view, which was a modification of the filming procedures reported by Elliott & Reid (2002). The ball was delivered using an inclined serving stand similar to the device used by Akutagawa & Kojima (2005) and shown in Figure 1.

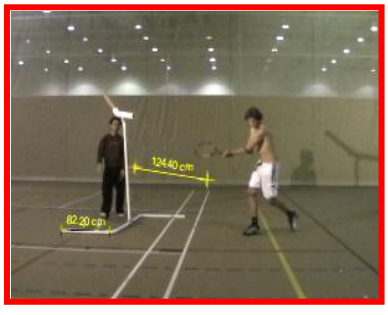

Figure 1: Serving stand

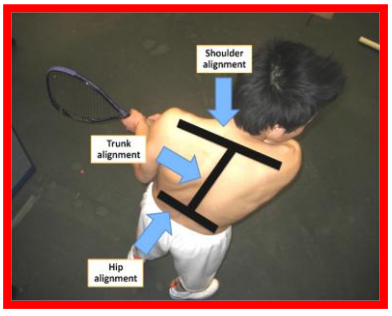

Figure 2: Initial body alignments

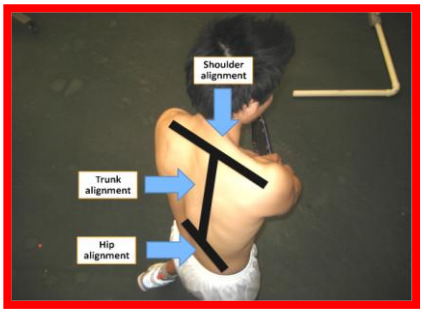

Figure 3: Ball Contact alignments

After 5 warm-up strokes, the subjects continued hitting backhand ground strokes until 10 trials of each striking technique, and each power level landed in the target area. The

average velocities for the moderate and maximal strokes were calculated and then the 2 trials closest to the average velocity for the stroke combination which landed into the target zone were selected. The 80 trials in the zone out of a total of 400 trials were digitized using an Ariel APAS, transformed using the 3 DLT, and smoothed using a 2nd order Butterworth digital filter with a smoothing cut-off of 10 Hz. The angular alignments of hip, shoulder and trunk rotations were determined at the initiation of forward swing and at ball contact as shown in Figures 2 & 3. Dependent variables of shoulder, hip, and trunk rotation were calculated and analyzed using a 2x2x2x2 ANOVA (gender, technique, power, & trials) with repeated measures on the technique, power and trial factors.

RESULTS: The mean age, height and weight of the subjects were 19.6±2.3 yrs, 178.0±12.0cm, and 73.3±18.5kg, respectively. The tennis players placed 186 out of 400 trials in the target zone which represented a placement accuracy of 46.5%.

Table 1: Average ball velocities expressed as m*sec^{-1} for stroking technique and power level.

Technique Power	1 handed Maximal n=20	1 handed Moderate n=20	2 handed Maximal n=20	2 handed Moderate n=20
Male	31.2 ± 3.6	22.9 ± 2.8	32.3 ± 3.0	26.1 ± 5.0
Female	25.5 ± 1.3	21.9 ± 1.5	28.8 ± 2.0	22.9 ± 2.4

The results for the amount of shoulder rotation about the vertical axis found significance for the hand technique (p=.000), power (p=.000), and an interaction of the power*gender factors. The mean shoulder rotations for the male and female players using a 1 & 2 handed backhand with 2 power levels are presented in Table 2 and in Figure 4. A significant main effect for hand technique (p=.003) was found for the hip rotation variable. Subjects using 2 hands in the backhand stroke exhibited a hip rotation of .89 rad (50.8 deg) and the 1 hand backhand needed only .50 rad (28.8 deg) and is shown graphically in Figure 5.

Table 2: Body rotations during 1 & 2 hand tennis backhand at moderate & maximal power levels.

Rotation (Radians)		1HMax (M ± SD)	1HMod (M ± SD)	2HMax (M ±SD)	2HMod (M ± SD)
Shoulder Rotation	**Male**	.90 ±.29	.56 ±.29	1.49±.22	1.32 ±.14
	Female	1.03±.48	.86 ±.34	1.46±.23	1.31 ±.26
Hip Rotation	**Male**	.46±.40	.41±.40	1.03±.21	.99±.19
	Female	.58±.43	.57+.38	.76±.26	.98±.18
Trunk Rotation	**Male**	.45±.36	.23±.17	.48±.25	.33±.19
M n=5**, F** n=5	**Female**	.45±.17	.28±.12	.71±.09	.53±.23

The hip rotation variable was found to have significant gender (p=.01) and power (p=.05) main effects exist. The mean trunk rotations for the male and female players using a 1 & 2 handed backhand with 2 power levels are presented in Table 2 and graphically in Figure 6. The trunk rotation variable was found to have significant gender (p=.01) and power (p=.05) main effects exist. There was a significant 4 way interaction (p=.049) between the technique, power level, trial, and gender factors. The mean trunk rotations for the male and female players using a 1 & 2 handed backhand with 2 power levels are presented in Table 2 and graphically in Figure 7.

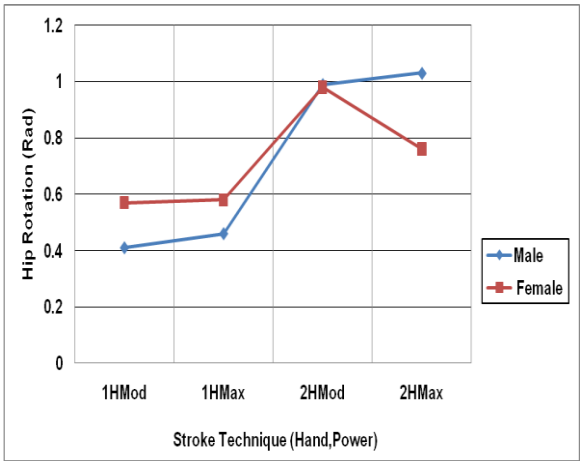

Figure 4: Shoulder rotation used hitting 1 & 2 handed backhand tennis strokes with mod. & max power.

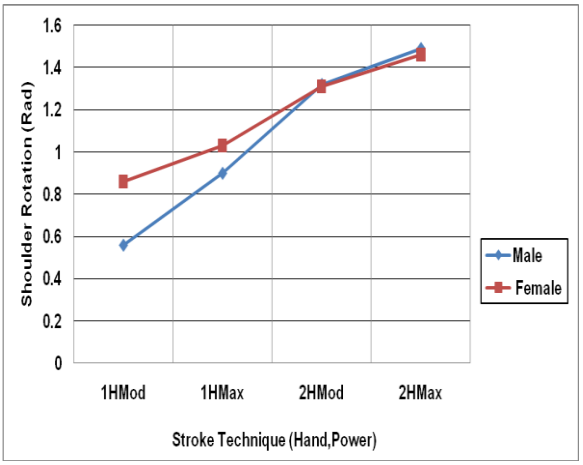

Figure 5: Hip rotation used hitting 1 & 2 handed backhand with mod. & max. power.

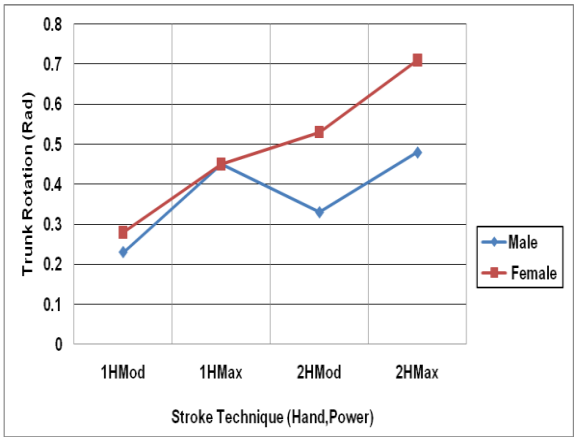

Figure 6: Trunk rotation used hitting 1 & 2 handed backhand with mod. & max. power.

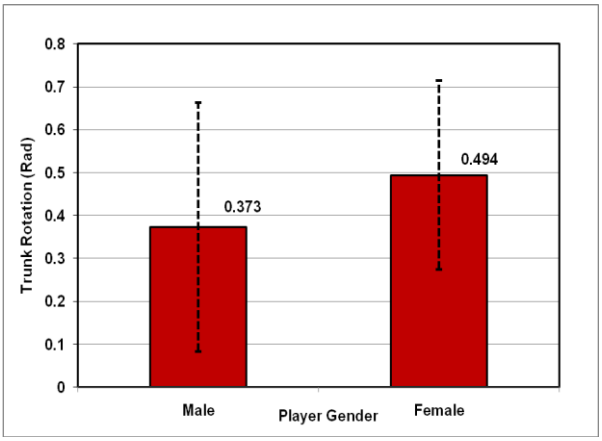

Figure 7: Trunk rotation used by male & female tennis players.

DISCUSSION: Although, statistically non-significant the female tennis players utilized about 10% more shoulder rotation than the male players in generating their racquet head velocity while using the same striking technique. The 2 handed backhand required significantly 12% more shoulder rotation which could have some implications on facet or lower back discomfort. The 1 hand backhand tended to leave the left arm to lag behind the trunk whereas the right arm in the 2 hand backhand provided the momentum of the stroke. This study reported results similar to a study by Elliott (1989) where it was found that shoulder rotation was a major contributor to racquet head velocity. Also, the present study found that 20% more shoulder rotation was used to hit with maximal power shown in Figure 4. The significant hand technique for the hip rotation variable might have been the result of different mechanics used in the 2 swing techniques. This finding was consistent with the results reported in a study by Akutagawa & Kojima (2005). In the 2 hand backhand, the left hand gripping the racquet facilitates the left shoulder and left hip to carry the momentum throughout the forward movement. Additionally, there was a significant (p=.05) interaction between technique and gender for the hip rotation variable. Males used less hip rotation than females in the 1 handed stroke but males used more hip action in the 2 handed stroke in order to generate the higher ball velocities when using the 2 hand backhand. This study found that the players utilized more trunk rotation when maximal power (.52rad, 29.8deg) was used instead of moderate power (.35rad, 19.8deg). Also, it was found that greater trunk rotation of (.51rad, 29.4deg) was utilized when the players used 2 hands for their backhand

rather than a 1 handed backhand (.35rad, 20.1deg). Ranges of motion of this magnitude were reported by Toren (2001) to result in limited muscle involvement occurring when trunk rotation movement was in the range of 10-15 degrees either side from anatomical mid-sagittal plane (neutral position). It was suggested that, if trunk rotation movement approached the end of range of motion (ROM), it might load the structures (disks, joints, ligaments) which are more sensitive, cause discomfort or pain, and have the risk of spinal disorder.

CONCLUSIONS: Greater shoulder rotation occurred when subjects performed a 2 handed backhand, which in turn increased the trunk range of motion and may be a contributing factor in low back problems in tennis players. Also, when hitting with maximal power the players used more shoulder rotation to generate the racquet head velocity. Hip rotation was significantly increased when using 2 hands in the backhand. Female subjects had greater shoulder rotation but less hip rotation producing more trunk rotation while the male players used the hips and shoulders to generate racquet head velocity which in turn created less trunk rotation/torque. The greater trunk rotation demonstrated by females could possibly place them at higher risk of low back injuries and using a 2 handed backhand increases the trunk rotation as compared to a 1 hand stroke.

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