LUNGE FORCES AND TECHNIQUE OF JUNIOR SQUASH PLAYERS

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INTRODUCTION: The lunge movement is used regularly in squash, as well as in other sports such as badminton and fencing, and the ability to complete a controlled lunge quickly can be a crucial part of the game (Cronin, McNair, & Marshall, 2003). The lunge has been recognised as placing high physical demands on the lower limbs, with vertical ground reaction forces (GRF) exceeding 2.5 times body weight during a badminton lunge (Kuntze, Mansfield, & Sellers, 2010). There have been a number of studies examining the forces produced by adult athletes performing a lunge movement (Lees & Hurley, 1994; Kuntze, Mansfield, & Sellers, 2010), however, to date there is very little information on the kinetics or kinematics of the squash lunge technique as performed by junior athletes. The aim of this study was to quantify and compare the ground reaction forces produced by junior squash players while performing a simulated forehand and backhand lunge shot.

METHOD: Nine male junior squash players participated in this study (age 14.53 ± 1.96 yrs, height 1.62 ± 0.05 m, body mass 54.2 ± 9.3 kg). Subjects were divided into 2 groups according to their playing ability: Experienced Juniors (EJ), n=4 and Developing Juniors (DJ), n=5. Subjects were required to run a distance of approximately 4 m before lunging forward onto one leg, performing a ghost shot, then pushing off and returning to the start position. Three forehand (FH) and three backhand (BH) trials were performed by each subject. Data for each trial were collected via 12 Vicon MX-13 cameras (OMG, England) and Kistler force plates (Kistler, Switzerland) through Vicon Nexus software at 500 Hz. Each subject was marked up according to the standard lower-body Vicon Plug-in Gait model. The 3rd trial for each subject was chosen for analysis to eliminate any learning effect. The variables chosen for analysis were: knee angle at touchdown and takeoff; max knee flexion; approach angle; total contact time; max horizontal and vertical GRF; and vertical impulse. The vertical GRF component was further broken down into 6 variables, as classified by Lees & Hurley (1994) (identifiable in Figure 1); A: initial impact peek (heel strike), B: impact loading, C: amortization (force reduction), D: loading (weight acceptance), E: drive-off, PFR: peak force reduction, difference between B and C. Statistical significance was assessed using a two-way ANOVA (SPSS) with 2 factors corresponding to ability (EJ and DJ) and stroke (FH and BH). Significance was set at $p < 0.05$. Post-hoc analysis was done via a student t-test.

RESULTS: A typical vertical (Fz) GRF curve for a subject from the EJ and DJ group during a FH lunge can be seen in Figure 1.

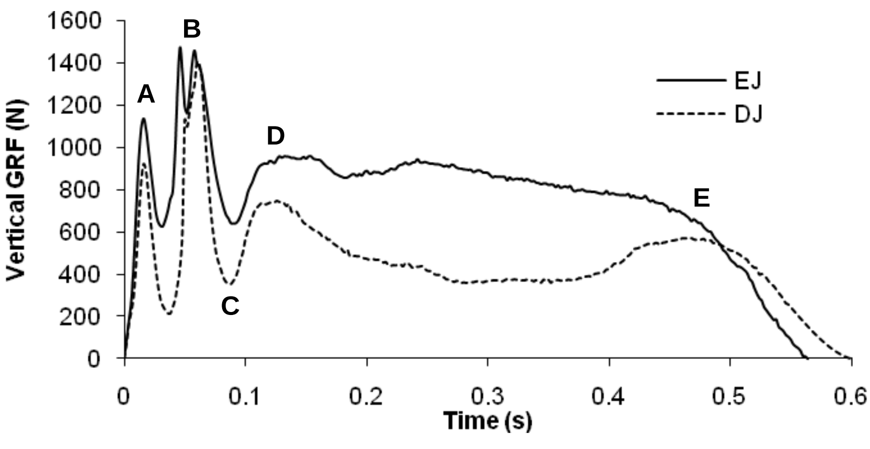

Figure 1. A typical Fz GRF curve for a subject from the EJ and DJ group during a FH lunge.

There were no significant differences found between the forehand and backhand strokes for any of the variables evaluated. A summary of the mean data (relative to body weight) for the 6 vertical GRF variables are presented in Table 1. Initial impact peak (A) was significantly higher, while impact loading (B) and peak force reduction (B-C) was significantly lower for the EJ group compared to the DJ group (see Table 1). There were no other significant differences between abilities for any of the other kinetic or kinematic variables measured.

Table 1. Mean vertical (Fz) forces relative to body weight (N) during the lunges.

		Experienced Junior	Developing Junior	*p* value
A	Initial impact peak	2.49 ± 0.48	1.92 ± 0.26	0.017*
B	Impact loading	2.44 ± 0.30	3.22 ± 0.38	0.006*
C	Amortization	1.01 ± 0.16	0.94 ± 0.16	0.473
D	Loading	1.57 ± 0.18	1.66 ± 0.09	0.271
E	Drive-off	1.34 ± 0.09	1.26 ± 0.09	0.157
B-C	Peak force reduction	1.43 ± 0.26	2.28 ± 0.37	0.003*

*$p < 0.05$

DISCUSSION: There were no significant differences between any variables when comparing FH to BH, suggesting that even though subjects were using alternate legs, they produced similar force curves/magnitudes and performed the lunge with similar kinematics. The lower initial impact forces (A) and higher impact loading forces (B) in the DJ group is most likely the result of landing with a slightly straighter leg, combined with a more flat-footed strike than the EJ group. The DJ group tended to begin knee flexion later, after the foot was completely flat on the ground, suggesting the inexperienced players had not yet developed the appropriate coordination and movement skills, or strength, to reduce this aspect of the impact force (Lees & Hurley, 1994). Furthermore, the greater peak force reduction seen in the DJ group may also indicate an inferior ability of the developing players to efficiently utilize the high impact loading experienced during the lunges.

CONCLUSION: This study showed that developing junior squash players tended not to be able to efficiently utilise the high impact forces generated during impact loading. They appear to have not developed the necessary coordination and movement skills to reduce the affect of impact loading. It was also shown that there were no significant differences in the measured variables between forehand and backhand lunges as performed by this group of male junior squash players. The main limitation of this study was the small sample size of each group. Further investigation with a larger sample size is recommended in order to gain a greater understanding of the lunge forces and technique of junior squash players.

REFERENCES:

Cronin, J., McNair, P.J. & Marshall, M.N., (2003). Lunge performance and its determinants. *Journal of Sports Sciences, 21,* 49-51.

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

Lees, A. & Hurley, C. (1994). Forces in a badminton lunge movement. In T. Reilly, M. Hughes, & A. Lees (Eds.), *Science and Racket Sports* (pp. 186-189). London & New York: Taylor & Francis.

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