GENDER DIFFERENCES IN PEAK VERTICAL GROUND REACTION FORCE AND RATE OF LOADING DURING STOP-JUMP TASK

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INTRODUCTION

Females have been found to have eight time higher anterior cruciate ligament (ACL) injuries incidence compared to males participating in the same sport activities (Boden & Dean, 2000). It is further reported that 70% of these injuries occur during landing from a jump (Boden & Dean, 2000). Supposing that one of the possible implications for high knee injuries in females is imposed impact forces on their lower extremities during landing, the purpose of this study was to examine gender differences in peak vertical ground reaction forces (VGRF) and rate of loading (ROL) during stop-jump task.

METODS AND PROCEDURES

44 healthy (22 males, weight of 75.89±3.22 kg, height of 177.84±4.52 Cm, age of 24±3 years, and 22 females, weight of 64±2.85 kg, height of 164±5.58 Cm, and age of 22±2 years) participated in this study. 50% of maximum high jump of subjects calculated. Subjects were asked to jump from the distance of 70 Cm from force plate with two legs and after touching the sign of 50% of high jump, landing on center of force plate with preferred leg. We determined (VGRF) as the peak vertical force (N) recorded during landing, normalized for body weight (N), and expressed as a multiple of body weight (BW). ROL was calculated as the normalized peak vertical force divided by the time to peak force.

$$ROL = \left[\frac{peakFz(N)/BW(N)}{t} \right] = \frac{BW}{ms}$$

Multivariate analysis of variance (MANOVA) was used to compare peak VGRF and ROL between two groups at the p level of 0.05.

RESULTS

Significant differences found between males and females ($F_{1,41}$=5.627, Wilks' Lambda = 0.372, P≤0.05). This differences was attributed to differences in ROL, while no significant differences have been found between two groups in peak VGRF ($F_{1,42}$ = 2.818, P > 0.05). Mean force-time curve for males and females have presented in figure 1.

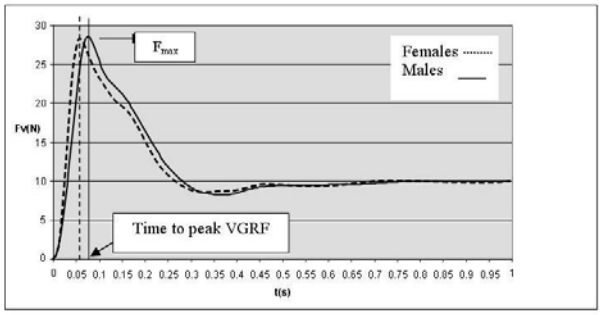

Figure1: force-time curve for males and females during landing

As it is seen in figure 1, the mean of peak VGRF are adequate between two groups,

but females reach to peak VGRF 20% faster than males. It results in 15.85% increase in ROL in females than males and this difference is significant at p level of 0.05.
The mean and standard deviation of peak VGRF and ROL for males and females and the results of MANOVA presented in the table of 1.

parameter	groups	mean±Sd.	$F_{1,42}$	P
Peak GRF (N)	males	29.80±4.30	2.818	0.101
	Females	28.40±4.90		
ROL (N/s)	males	403.20±98.50	5.627	0.022*
	Females	479.10±113.30		

Table 1: mean and Std. peak VGRF and ROL of males and females.* significant at p level of 0.05

DISCUSSION

The purpose of this study was to examine gender differences in peak VGRF and ROL during jump-landing task. With respect to the results, increase the ROL in females can increase the knee ROL secondary, and subsequently increase the probability of knee injuries, especially ACL in females than males. Increasing the ROL in females might be explained with respect to differences in landing pattern and neuromuscular control.
Past research has reported that females had significantly lese knee flexion at contact to same male athletes (Lephart & Ferris, 2002; Decker & Torry, 2003). This situation decreases their ability to attenuation forces imposed to their body (Boden & Dean, 2000). Researchers suggested that the more extension in joints during touching the toes with ground, the less time to dissipate the impact and the more impact of GRF and ROL imposed to their body (Boden & Dean, 2000; Hewett & Stroupe, 1996; Lephart & Ferris, 2002). This increase in ROL can impose stress on the soft tissues of the knee, especially ACL and injure this structure. it is, Also, suggested that the impact of GRF imposed to the body during activities can be dissipated by eccentric activity of the lower extremities muscles (Coventry & O'Conner, 2006). It is possible that females have less neuromuscular response than males to dissipate the load during landing. Previous studies demonstrated that females may benefit from neuromuscular training programs that are designed to decrease GRF (Hewett & Stroupe, 1996). Neuromuscular training can increase proprioception and muscle strength in females and secondary their ability to absorb the shock of GRF and ROL. It is possible that females' muscles have reduced ability to absorb the impact during contact with ground.

SUMMERY

ROL significantly difference between males and females participated in this study. One possible reason for higher expectation on non-contact ACL injuries in females compared to males can be considered as result of high ROL imposed to their lower extremities during landing. To reduce the risk of knee injuries, it seems to be suggested to focusing on neuromuscular training and landing strategies in females' athletes.

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