GENDER DIFFERENCES IN LOWER EXTREMITY STIFFNESS DURING DROP LANDING FROM DIFFERENT HEIGHTS

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Introduction

The rate of lower extremity injury in females was higher compared to males during athletic competition [Arendt, 1995]. Previous study has indicated that compared with males, females use different kinematics, particularity during landing when exposed to increased ground reaction forces, which increases the risk of lower extremity injury [Granata, 2002; Yu, 2006]. Based on this result, we infer that females cannot modulate their joint stiffness appropriately to lessen the impact when landing. Therefore, it is important to investigate the gender differences in movement strategy and modulation during landing to clarify the factors affecting the lower extremity load on females.

Methods

Twelve male and twelve female subjects were recruited from a university Physical Education Department. Each subject performed a landing task from drop heights of 40 and 60 cm. Kinematic data were collected by a seven-camera motion analysis system (Qualisys motion system) sampling at 200 Hz. Ground reaction forces were collected by two AMTI force plates (1000 Hz). All of the kinematics and kinetics data were calculated in the MotionMonitor software package. The mass-spring model was used to calculate the lower extremity stiffness. A 2×2 (gender × height) mixed-factors two-way ANOVA was used to test the differences between genders in terms of vertical ground reaction force (VGRF) and stiffness (k) during the landing phase.

Results

The study found that increasing the impact load from DL40 to DL60 reduced the vertical stiffness (kv) (p=0.029) and the knee joint stiffness (kknee) (p=0.036), but the peak VGRF was increased (p＜0.001) in females (Table 1). Furthermore, the kv (p=0.029) and kknee (p=0.035) were smaller in females than in males during DL60. No statistically significant differences were found among the biomechanical variables measured between DL40 and DL60 in males.

	Females	Males
DL40 VGRF (BW)	2.80 (0.73) †	3.06 (1.00)
DL60 VGRF (BW)	3.93 (0.50) †	3.71 (1.36)
DL40 k_v (BW/LH)	4.37 (2.25) †	4.91 (1.92)
DL60 k_v (BW/LH)	3.28 (1.23) †§	4.59 (1.28) §
DL40 k_{knee} (BW*BH /rad)	0.18 (0.06) †	0.22 (0.09)
DL60 k_{knee} (BW*BH /rad)	0.16 (0.05) †§	0.21 (0.07) §

Table 1: VGRF and lower extremity stiffness during drop landing. †P<0.05 significant differences between height. §P<0.05 significant differences between gender.

Discussion

There was a relationship between the proper stiffness adjustment and the precautions taken to minimize lower extremity injuries during the movement [Butler, 2003; Williams, 2004]. Previous study indicated that increasing the height would not be dangerous for the subjects, and thus the joint stiffness would remain the same during drop landings from different heights [Hu, 2011]. Hence, we inferred that the drop height increase from 40 cm to 60 cm was not dangerous for the males, who can buffer the landing sufficiently, and so the impact load and lower extremity stiffness remained unchanged during the landing. Nevertheless, when the drop height increased to 60 cm, this might seem dangerous to the females, causing them to buffer the landing insufficiently and increase the impact load. However, this insufficient buffering was accompanied by a decrease in the vertical stiffness and knee joint stiffness. Therefore, the vertical stiffness and knee joint stiffness in females was smaller than that in the males during the 60 cm drop landing. As reported in past studies of stiffness and injury, smaller vertical stiffness and knee joint stiffness values during landing in females reduce the joint stabilisation and increase the injury risk for the lower extremities, especially the knee joints [Granata, 2002; Hughes, 2008].

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