

GENDER DIFFERENCE IN KNEE MOTION PATTERN DURING VERTICAL JUMPHsiao-Yun Chang*, Wen-Shin Hsu, Jinn-Yen Chiang, Shao-Yi Liu, and Hsien-Chen Ho[§]

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Several factors have been proposed as contributors to increase the injuries rate on non-contact ACL rupture among female athletes. Altered movement pattern may results in increased incidence of non-contact ACL injuries for female athletes. Therefore, the purpose of this study was to compare the knee kinematics difference between male and female athletes. Eighteen athletes were participated in this study, including 10 male and 8 female. The Zebris 3 D ultrasound-based system was used to measurement the knee kinematics during vertical jump. The results were shown that there had significant difference in knee maximal flexion, internal rotation, and flexion angle at maximal knee abduction between male and female athlete during vertical jump. Female athletes had showed little change of flexion angle and internal rotation angle of knee during vertical jump.

KEY WORDS: Knee, Gender, Kinematics.

INTRODUCTION:

Anterior cruciate ligament (ACL) injury is a common sports injury, especially in females (Deitch, 2006). Gender-based differences in injury rates have been reported in some sports events (McLean, 2005; Sigward, 2005). ACL injury rates between male and female athletes participating in the same sport have shown 2–8 times greater incidence in females (Arendt, 1995; Malone, 1993; Messina, 1999). Several factors have been proposed as contributors to increase the injuries rate on non-contact ACL rupture among female athletes. Those factors included altered neuromuscular firing strategies and movement pattern were results in increased incidence of non-contact ACL injuries for female athletes (Malinzak, 2001; Swanik, 1999).

Previous studies was showed women tend to have less knee flexion angle, more knee valgus angles in comparison to men during athletic tasks (Malinzak, 2001; James, 2004). But less researches have been analyzed the movement pattern at terminal knee flexion for athletic-specific movement. Therefore, the purpose of this study was to comparison of the movement pattern at terminal knee flexion in vertical jump movement between different genders.

METHOD:

The study was conducted on 10 male (height: 178.8±6.1 cm, weight: 73.6±12.6 kg, age: 20.9±1.2 years) and 8 female (height: 161.3±4.3 cm, weight: 56.9±6.4 kg, age: 21.2±2.2 years) collegiate athletes to perform the measured activities. Knee kinematics analysis was performed by applying the Zebris three-dimensional ultrasound-based system CMS-HS (Medical GmbH, Tübingen, Germany) during vertical jump. Two triple-head ultrasound passive sensors were placed on below 10 cm from greater tuberosity of femoral bone and above 10 cm of lateral malleolus of ankle, separately (Figure 1). The ultrasound receiver plate was placed at the side of the measured leg away from 50 cm. Each subject was performed 5 repeated movements of the vertical jumping. The WinData Software (Medical GmbH, Tübingen, Germany) was used to collect and analyze the knee joint kinematics data. The 8 knee kinematics variables, including max knee flexion, max knee abduction/adduction, max knee internal/external rotation, flexion angle at max knee abduction/adduction and flexion angle at max knee external rotation, were selected to as dependent variables of this study. The knee kinematics data from knee extension 0 degree to flexion 30 degree was extracted to plot the related motion. The reason to extract the knee terminal flexion 30

degree was that this range is the danger zone for anterior cruciate ligament injuries if knee placed on more adduction and external rotation. Gender difference was the independent variable in the study. Independent T-test was used to determine the difference between genders of collegiate athletes.

RESULTS:

The result was showed that there had significant difference in knee maximal flexion, internal rotation, and flexion angle at maximal knee abduction between male and female athlete during vertical jump. Female athletes had showed more flexion angle and internal rotation angle of knee during vertical jump (Table 1). Male athletes also have been found less knee flexion angle as the knee at maximal adduction degree during vertical jump (Table 1). The knee kinematics data from knee extension 0 degree to flexion 30 degree was extracted to plot the related motion (Figure 2 to 4). Figure 2 was represented the knee average abduction angle related to knee terminal flexion 30 degree. It was shown female athletes placed the knee in adduction position, and then moved to abduction, and go back to adduction during knee flexion 30 to 0 degree. The male athletes were shown few different in knee motion pattern with compare to female athletes at knee abduction related to knee terminal flexion 30 degree. The male athletes were shown slightly increased the abduction angle during knee flexion 30 to 0 degree. Figure 3 was represented the average angle of knee external rotation related to knee terminal flexion 30 degree. It was found female athletes increased about 3 degree of the knee external rotation degree during knee flexion 30 to 0 degree. Figure 4 was shown the average angle of knee in external rotation related to knee abduction motion at terminal knee flexion 30 degree. It was found female athletes tended to more external rotation and adduction degree.

Table 1. Gender difference of knee kinematics variables during vertical jump

Variables [§]	Male	Female	difference	t	df	P value
Max flex; deg	91.1±20.2	117.8±19.8	-26.70	-2.70	15	.02*
Max abd; deg	7.9±9.5	3.6±2.8	4.35	1.24	15	.23
Max add; deg	4.8±4.9	9.0±8.8	-4.18	-1.19	13	.26
Max ER; deg	9.4±7.9	7.7±11.4	1.72	.35	14	.73
Max IR; deg	5.8±4.3	14.0±8.4	-8.17	-2.51	13	.03*
Flexinabd; deg	49.2±32.8	32.1±33.1	17.15	.97	12	.35
Flexinadd; deg	43.5±28.1	110.2±19.8	-66.66	-5.01	14	.00*
FlexinER; deg	56.9±39.5	36.0±31.1	20.97	1.17	15	.26

* means $P < .05$

§ Max flex: maximal knee flexion, Max abd: maximal knee abduction, Max add: maximal knee adduction, Max ER: maximal knee external rotation, Max IR: maximal knee internal rotation, Flexinabd: flexion angle in maximal knee abduction, Flexinadd: flexion angle in maximal knee adduction, FlexinER: flexion angle in maximal knee external rotation.

DISCUSSION:

The main findings of the study indicated that female athletes significantly increased the angle in maximal knee flexion, maximal knee internal rotation, and flexion angle in maximal knee adduction than the male athletes during vertical jump. Previous studies have shown similar results that female exhibit greater knee flexion profile with greater knee flexion angular velocities that may actually protect the ACL by dissipating forces over the larger range of motion (Decker, 2003; Kernozek, 2005). Several researchers have identified gender differences in knee kinematic landing profiles in sagittal or frontal plane (Malinzak, 2001; Decker, 2003; Ford, 2003; Kernozek, 2005). That suggest that gender difference in knee biomechanics exist in knee flexion/extension or adduction/abduction, not in transversal plane during sports-specific task. However, in our study presented the gender difference was found in maximal knee internal rotation during vertical jump. The result in current study was not support the previous finding. We hypothesized that the female athletes may use different movement strategy to performed highly-level sports task. Most studies suggest coupled

movement in the sagittal, frontal, and transverse planes may contribute more to ACL injury than single plane movement alone (Kernozek, 2005; McLean, 2004; Pflum, 2004). In current study, the knee kinematics data from knee extension 0 degree to flexion 30 degree was extracted to plot the coupled motion including valgus and external rotation related to terminal knee flexion. The results were shown female athletes have little degree change external rotation and varied valgus motion that male athlete as knee from flexion 30 to 0 degree. There was indicated that some instability was found for female athletes during lasting 30 degree of knee flexion. In current study, the selection of knee kinematics variables was a critical point to look for the difference between genders as subjects perform the sports-specific tasks. The maximal knee angles during dynamic task were no significant difference except the angle of maximal knee flexion and internal rotation. There have indicated that it was controversial to select the maximal angle of knee as the kinematics variables of this study. Another study limitation was not considerate the anthropometry difference between male and female. In future study, we will focus on selection the optimal knee kinematics variables to differential between genders.

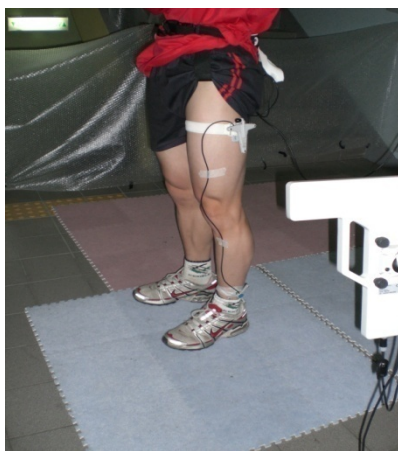


Figure 1: The location of the triple-head ultrasound passive sensors.

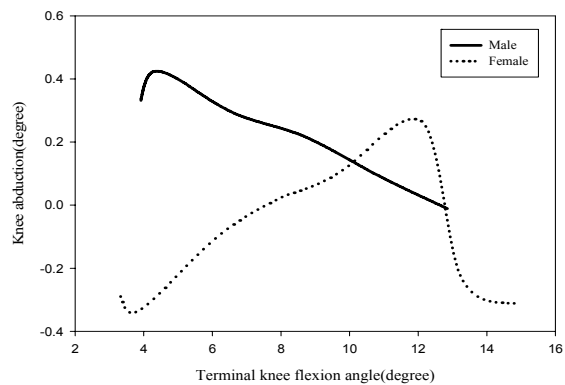


Figure 2: Gender difference in average angle of knee abduction at terminal knee flexion 30 degree during vertical jump.

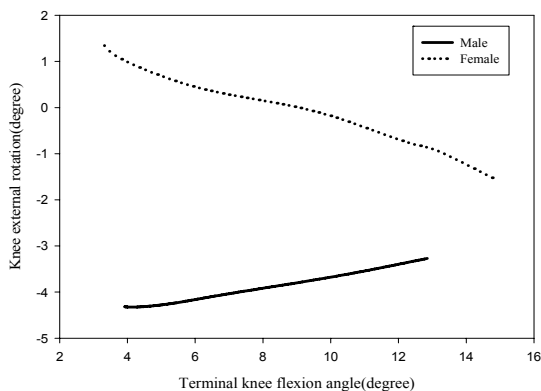


Figure 3: Gender difference in average angle of knee external rotation at terminal knee flexion 30 degree during vertical jump.

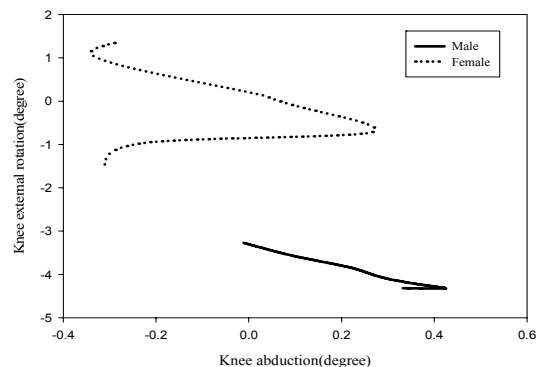


Figure 4: Gender difference in average angle of knee abduction in related to external rotation degree at terminal knee flexion 30 degree during vertical jump.

CONCLUSION:

Female athletes had showed more flexion angle and internal rotation angle of knee during vertical jump. The results were also shown female athletes have more external rotation and varied valgus motion that male athlete as knee from flexion 30 to 0 degree. There was indicated that more instability was found for female athletes during lasting 30 degree of knee flexion. Future study would considerate the anthropometry difference and hormone effect for knee kinematics of female athletes.

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