

THE EFFECTS OF MID-AIR ADJUSTMENTS ON KNEE JOINT LOADING WHEN LANDING FROM A JUMP

Guan Q. Tan¹ and Timothy R. Derrick¹

¹Department of Kinesiology, Iowa State University, Ames, IA, USA
gqtan@iastate.edu URL: <http://www.hhp.hs.iastate.edu>

INTRODUCTION

One of the most common injuries involving the knee joint is an anterior cruciate ligament (ACL) tear. Female basketball and soccer players have about 3 times higher risk of ACL injury versus male athlete counterparts (Prodromos et al., 2007).

Mid-air adjustments to the upper extremities will cause equivalent reactions in the lower extremities. This may cause jumpers to land asymmetrically and possibly increase the potential for ACL injuries. Variables of interest in ACL injury potential include knee shear forces, knee adduction moments and knee internal rotation moments (McLean et al., 2007). The purpose of this study was to determine if these variables are affected by landing from a jump with mid-air adjustments.

METHODS AND PROCEDURES

Eleven healthy college female students (age 21.8 ± 1.62 yrs, height 1.7 ± 0.5 m, mass 64.1 ± 11.7 kg) participated in the study. Three tennis balls were suspended from the ceiling according to Figure 1. After maximum jump height was established, subjects were instructed to jump from and land on two force platforms (AMTI, 1000 Hz). Approximately 100 ms after leaving the force platform an LED positioned near one of the balls was illuminated. Subjects were asked to tap this ball using both hands. They were told to jump as high as possible for each of 21 randomly selected trials. A total

of 23 retroreflective markers on the right and left lower extremities were used to determine the 3D orientation of the segments (Peak Motus, 120Hz).

Inverse dynamics were used to calculate joint moments and reaction forces at the knee joint. Kinematics were imported to a scaled SIMM (MusculoGraphics, Inc.) model to obtain the maximal muscle forces, muscle moment arms and muscle orientations for 88 lower extremity muscles. Static optimization using a cost function that minimizes the sum of the muscle stress squared was used to estimate the individual muscle forces. The knee joint contact forces were then calculated as the sum of the muscle forces and the joint reaction forces. The peak adduction knee joint moment, peak internal knee joint moment and peak anterior shear force were used to assess the potential for ACL injury. A 3 x 2 x 2 (reaching direction by right vs left leg by ipsilateral vs contralateral leg) repeated measures ANOVA was used to determine statistical significance.

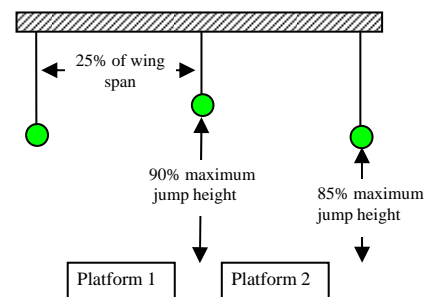


Figure 1. The jumping-landing tasks setup.

RESULTS

The average peak values for anterior shear force, rotation moment and adduction moment are given in Table 1.

	Reaching Direction	Ant. Shear Force	Rot. Mom.	Add. Mom.
Left Leg	Right	0.64 (0.56)	0.17 (0.10)	0.16 (0.08)
	Left	0.60 (0.55)	0.17 (0.09)	0.16 (0.08)
	Middle	0.59 (0.55)	0.14 (0.08)	0.14 (0.08)
Right Leg	Left	0.66 (0.51)	0.14 (0.09)	0.16 (0.10)
	Right	0.81 (0.57)	0.14 (0.07)	0.17 (0.10)
	Middle	0.68 (0.54)	0.11 (0.07)	0.15 (0.10)

Table 1. Mean (SD) of selected ACL injury potential variables during landing from a jump with possible mid-air adjustments. Forces are in body weights (BW) and moments are in BWm.

The anterior shear force was significantly greater on the right knee compared to the left and the rotation moment was significantly greater on the left knee compared to the right. However, data were also analyzed without reference to which leg had the highest peak values. The average peak difference between the middle ball condition and the greater value of the ipsilateral and contralateral legs from the side reaching conditions is given in Table 2. This shows that anterior shear forces, rotational moments and adduction moments all increased in one of the legs when reaching to the side.

Variables	average peak difference	p value
Ant. Shear Force	0.14 BW	0.05
Rot. Mom.	0.05 BWm	<0.01
Add. Mom.	0.03 BWm	0.02

Table 2. Loading increases during the side reaching conditions when compared to the middle reaching condition.

DISCUSSION

The results suggests that reaching to the side balls had a higher risk of ACL injury than reaching to the middle ball. This result was not apparent when looking at right/left leg effects or ipsilateral/contralateral leg effects because subjects adopted different strategies to deal with the mid-air adjustments that are necessary when reaching to a side ball. Some subjects always landed on their dominant leg, some subjects always landed on the ipsilateral leg etc.

SUMMARY

Understanding how the movement of the body in the air can affect the potential for ACL injury can be of benefit to athletes, coaches, athletic trainers and researchers. We found an increased potential for ACL injury when jumpers land from a jump in which they are required to reach to the right or left during the flight phase.

REFERENCES

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