BIOMECHANICAL DIFFERENCES BETWEEN GENDERS WHEN EXECUTING A LAND AND CUT MANEUVER

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INTRODUCTION

It is well documented that the knee is a commonly injured joint in male and female athletes. Many researchers have investigated the significantly higher incidence rate of non-contact ACL injuries in female athletes. [1,2,3]. It has been suggested that females are at risk for an ACL injury because they land with less knee flexion, and greater knee abduction than males while having weaker hip strength. Cutting and landing from a jump are most often identified as the activity at the time of injury. Consequently, investigators have tried to recreate these activities in an effort to define the injury mechanism and deduce factors that cause the injury rate difference between males and females. It has become apparent that a static landing activity, asking a subject to land and hold that position, does not adequately reproduce an authentic sport motion. In an effort to create a more realistic task, investigators have introduced landings followed by a vertical jump, while others have examined the cutting in an unanticipated direction to simulate a sport-related motion. The combination of landing and cutting has yet to be studied in the laboratory setting The purpose of this study was to attempt to recreate a landing condition that more closely resembled that seen in sport competition and evaluate landing kinematics. In this study landing and cutting were combined into a single event, more closely simulating motions seen in basketball, volleyball and soccer.

METHODS

Healthy, male (n = 22, age = 23(1.4)yrs, wt = 745(100)N, ht = 1.76(0.05)m) and female (n = 23, age = 22.4(1.5)yrs, wt = 600 (69.8)N, ht =1.65 (0.06)m) subjects provided informed consent prior to participating in this study. Subjects were marked with 37 reflective markers enabling 3-D reconstruction of a rigid linked model of the body. Six Falcon high-speed cameras (120Hz) imaged subjects while two Kistler force platforms measured ground reaction forces (960 Hz). Video and GRF data were synchronized at collection onset. Motion Analysis Corp. Eva software was utilized to obtain marker object-space coordinates. Subjects were imaged in a static position to enable determination of anatomically relevant coordinate systems [4]. Subjects were then instructed to land from a 60 cm platform and cut right, left or remain stationary after impact. The direction of cut was provided immediately prior to the subject leaving the platform. Table 1 provides a list of dependent variables. Three-dimensional kinematic variables were calculated using both KinTrak® and OrthoTrak® software T-tests, $p<.05$, were used in this preliminary analysis to compare the groups.

RESULTS AND DISCUSSION

Only kinematic data from the right leg (dominant leg in 44 of 45 subjects) for the land and right cut maneuver are reported here (Table 1). Subjects generally landed in slight knee and hip flexion. Males landed in greater knee flexion and reached a greater maximum knee flexion angle but total range of motion was not different between males and females. Both groups landed with slightly abducted hips and slightly adducted knees. Females remained abducted at the hip while the males obtained an adducted position through the remainder of stance. At the knee both groups moved into an abducted position. This knee motion is similar to that reported by Pollard et al. for a cutting maneuver [2]. No between group differences were observed for knee rotation, knee abduction, hip flexion or hip rotation variables.

Variable	Male (±SE)	Female(±SE)	P<.05
Angle at Impact (degrees)			
Knee Flexion	22.35 (1.50)	18.42 (1.02)	*
Knee Adduct	6.17 (1.40)	2.84 (1.60)	
Knee Ext Rot	4.23 (0.84)	2.54 (0.80)	
Hip Flexion	18.50 (1.39)	19.12 (1.03)	
Hip Adduct	-3.24 (0.83)	-5.05 (0.88)	
Hip Ext Rot	7.61 (1.03)	9.65 (0.88)	
Maximum or Minimum Angle after Impact (degrees)			
Knee Flexion	93.3 (1.54)	87.9 (1.52)	*
Knee Adduct	-6.17 (1.83)	-13.68 (3.34)	
Knee Ext Rot	5.17 (1.62)	9.56 (1.61)	
Hip Flexion	63.83 (1.73)	64.08 (1.80)	
Hip Adduct	5.68 (1.31)	-2.5 (1.21)	*
Hip Ext Rot	3.87 (1.22)	7.02 (0.99)	

Table 1: Comparisons (mean (SE)) of right leg hip and knee angles at impact and maximum range.

CONCLUSIONS

While the premise that females tend to land with less knee flexion and reach less maximal knee flexion while landing is supported in this study, no differences in knee abduction or rotation were observed. The greater hip abduction angle in females supports the idea that weakness at the hip may prevent females from establishing a safe landing position. With both the thigh and knee abducted, the knee is placed at risk for an injury upon landing as the weight of the body can, given sufficient hip abduction, potentially place a torque at the knee that cannot be actively controlled. Further evaluation of hip kinetics and associated muscle activity is warranted.

REFERENCES

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