THE RELATIONSHIP BETWEEN LEG DOMINANCE AND KNEE MECHANICS DURING THE CUTTING MANEUVER

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INTRODUCTION

Females have shown a 3-9 times greater risk for anterior cruciate ligament (ACL) disruption compared to their male counterpart while participating in sports that involve high risk jumping or cutting maneuvers [4]. These ACL injuries are non-contact (NC) in nature and are shown to occur more frequently in field and court sports such as soccer, rugby and basketball [1, 2]. Soccer is known as a predominantly lower extremity sport, where athletes are required to run, cut and kick over a 90 minute period. During this time, an estimated 60-80% of all injuries occur at the ACL [2, 3]. Female soccer players have also shown close to a 70% greater chance of sustaining an ACL disruption to their support leg or non-dominant limb (NDL) when compared to their kicking leg or dominant limb (DL) [2]. To date, few studies have looked into the role of limb dominance as a possible mechanism for NC ACL injuries in female soccer players.

Therefore, the purpose of this study was to examine the relationship between leg dominance and knee mechanics to provide further information about the etiology of ACL injury. We hypothesized that when compared to the DL, during the first-half of stance, the NDL will demonstrate altered knee joint mechanics.

METHODS

Fourteen healthy females who were NCAA Division I varsity soccer players volunteered as subjects for this study (age: 19.6 ± 1.3 yrs; body height: 168.0 ± 4.3 cm; body mass: 62.4 ± 6.1 kg). All subjects had a minimum of twelve years of soccer experience (14.1 ± 0.8 yrs) and at least one year of collegiate experience (1.9 ± 1.0 yrs). Prior to participation, each subject signed an informed consent document approved by the university IRB.

Subjects were fitted in standardized testing attire and asked to perform a five minute warm-up on a treadmill at a self-selected speed. Subjects were then instructed to perform a cutting maneuver; where they sprinted full speed a distance of 5m and then performed an evasive maneuver (planting on one leg and pushing off to the other leg in a new direction) at a 45° angle with their DL and NDL. Subjects were required to perform five successful cuts on each side given in a random order.

Three dimension kinematics and kinetics data were collected using a 12-camera motion capture system (240 Hz) (VICON Inc., Oxford Metric, London, England) and two AMTI force platforms (2400 Hz) (Advanced Mechanical Technologies Inc., Watertown, MA, USA). After the cutting trials, subjects performed bilateral isokinetic testing using a Cybex Norm dynamometer (Lumex, Ronkonkoma, NY, USA) at a speed of 60°/sec to evaluate knee muscle strength.

Power, moments, and angles in the knee were assessed during stance of the cutting maneuver. Paired Student t-tests were used to examine differences in knee mechanics between legs during the cutting maneuver. Significant level was set at 0.05.

RESULTS AND DISCUSSION

Knee joint mechanics in the DL and NDL were presented in Table 1. Subjects showed greater (P=0.01) power absorption in the NDL and greater (P=0.04) power production in the DL. The NDL also showed a greater (P=0.02) peak internal rotation angle. In addition, no differences (P>0.05)
in knee extensor and flexor isokinetic torques between the two limbs were shown.

The purpose of this study was to examine the relationship between leg dominance and knee mechanics during the cutting maneuver in healthy female soccer players. The results of this study were in agreement with our original hypothesis noting the NDL to demonstrate altered knee joint kinetics and kinematics. During the first half of stance, subjects exhibited significantly greater peak knee absorption power in their NDL. Although power absorption is expected in the knee during weight acceptance, it was interesting to discover that the magnitude of that power increased from the DL to the NDL. Increased power absorption reflects that increased energy is absorbed by the knee musculature and connective tissues such as ACL. Thus, it is possible that the NDL’s ACL may experience increased strain at weight acceptance of cutting. In addition, there is increased internal knee rotation in the NDL during cutting; increased internal knee rotation could also place the ACL under high tension [5, 7]. Thus, the increased power absorption coupled with greater internal knee rotation may result in increased risk of NDL ACL injury. Conversely, the DL demonstrated a significant increase in power production during the second half of stance. Similar studies have found that skill level holds an inference on cutting mechanics [6]. If the DL should possess more skill than the NDL, than an increase in power production in the DL would be expected in the cutting maneuver.

In this study, both limbs demonstrated similar knee extensor and flexor isokinetic torques. The similar knee strength between the limbs may be a result of proper strength training procedures at the collegiate level. Indeed, we failed to find a significant difference in the knee extensor moment between the limbs during cutting. Having equivalent limb strength in the DL and NDL could potentially decrease the variability in knee moments by stabilizing and strengthening the rigidity of the joint complex.

CONCLUSIONS

The results of this study show that a difference in knee mechanics during cutting does exist between the dominant and non-dominant limb. The findings of this study will increase the knowledge base of ACL injury in females and aid in the design of more appropriate neuromuscular, plyometric and strength training protocols for injury prevention.

REFERENCES


Table 1: Knee joint mechanics in the DL and NDL during the cutting maneuver [mean (standard deviation)].

<table>
<thead>
<tr>
<th>Dependent variables</th>
<th>Conditions</th>
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<tbody>
<tr>
<td>Knee joint mechanics</td>
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<tr>
<td>Power absorption (W/kg)</td>
<td>DL: 16.10 (3.79)</td>
<td>NDL: 18.56 (5.76)</td>
<td>0.014*</td>
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<td>Power production (W/kg)</td>
<td>DL: 13.00 (2.59)</td>
<td>NDL: 11.33 (2.51)</td>
<td>0.038*</td>
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<td>Peak internal rotation (°)</td>
<td>DL: 19.05 (5.76)</td>
<td>NDL: 22.45 (5.25)</td>
<td>0.018*</td>
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<td>Peak isokinetic extensor torque (Nm/kg)</td>
<td>DL: 160.91 (38.09)</td>
<td>NDL: 162.05 (30.78)</td>
<td>0.817</td>
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<tr>
<td>Peak isokinetic flexor torque (Nm/kg)</td>
<td>DL: 83.83 (18.22)</td>
<td>NDL: 84.81 (16.24)</td>
<td>0.643</td>
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* Denotes a significant difference between DL and NDL.