EFFECTS OF FEMALE MATURATION ON THE LOWER EXTREMITY BIOMECHANICS DURING THE SIDE-STEP TASK

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INTRODUCTION: Anterior cruciate ligament (ACL) injuries are among the most common knee injuries in sports (DeHaven & Lintner, 1986). Female athletes have demonstrated an increased susceptibility to ACL injuries compared to their male counterparts (Yu et al., 2005). The differences in neuromuscular performance during and after puberty may be important contributors to forces on the knee and altered biomechanics could potentially explain the increased risk of ACL injury in females (Quatman et al., 2006). The purpose of this study was to investigate the effects of female maturation on the lower extremity kinematics and kinetics during the side-step task.

METHOD: Twenty-two females participated in this study. The participants were divided into two groups (11 on puberty, age: 12 to 14, height: 152.8±3.9cm, weight: 39.7±5.1kg; 11 post puberty; age: 19 to 21, height: 160.3±3.5cm, weight: 49.8±3.7kg). All participants listed recreational sports, such as basketball and volleyball, as their primary sport. There were no differences in neuromuscular training experience between two groups. The modified Pubertal Matuational Observational Scale (PMOS) was used to classify participants into the 2 maturational categories, on puberty (equivalent to Tanner stages 2 and 3), post puberty (equivalent to Tanner stages 4 and 5), and was assessed during each screening session using parental questionnaires and investigator observations (Quatman et al., 2006). The side-step was performed by planting the right leg on the force platform and followed by left leg from the direction of approach with the approach speed controlled at 3.2±0.3m/s. Three-dimentional videographic (200Hz) and ground reaction force data (2000Hz) were collected performing a side-step task. Statistical analysis consisted of a multivariate test with the level of significance set at $P < .05$.

RESULTS: The post puberty participants exhibited a significantly greater foot external rotation angle than did on puberty participants (post puberty, 38.79°±14.77°; on puberty, 24.80°±6.94°; $P=.048$). The post puberty participants demonstrated a significantly greater shank abduction angle than did on puberty participants (post puberty, 12.92°±8.20°; on puberty, 5.37°±5.01°; $P=.039$). The post puberty participants had significantly greater thigh internal rotation angle than did on puberty participants (post puberty, 25.04°±9.57°; on puberty, 16.86°±4.57°; $P=.041$). Furthermore, the post puberty participants showed significantly greater knee extension moment than did on puberty participants (post puberty, 34.04Nm/kg±9.01Nm/kg; on puberty, 11.95Nm/kg ±9.80Nm/kg; $P=.043$).

DISCUSSION: Video analysis of ACL injury during competitive sports play indicates a common body position associated with noncontact ACL injury in which the tibia is externally rotated, the knee is close to full extension, the foot is planted and a deceleration occurs followed by valgus collapse (Hewett et al., 2004). Side-stepping with greater shank abduction, thigh internal rotation angles, and increased knee extension moment in the side-step task may increase the load on the ACL. Female neuromuscular patterns diverge during puberty

and show decreased adaptation after puberty. Thus, it appears that the growth and development associated with puberty are related to the neuromuscular and biomechanical factors that underlie the differences in ACL injury risk (Hewett et al., 2004). The results of this study provide that these angles and moments may increase the load on the ACL.

CONCLUSION: The post puberty participants have increased foot external rotation, shank abduction, thigh internal rotaion angles and knee extension moment during the side-step task compared to those of their on puberty counterparts.

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