LOWER EXTREMITY BIOMECHANICS OF FEMALE COLLEGE SOCCER AND BASKETBALL PLAYERS DURING SIDESTEP CUTTING

Chenfu Huang, Pohan Chang, Chiamei Li, Chinchang Liu

Department of Physical Education, National Taiwan Normal University, Taipei, Taiwan

The purpose of this study was to investigate the biomechanics of lower extremity between female college soccer and basketball players during a sidestep cutting. Twenty college players participated in this study. Ten Vicon cameras and a Kistler force plate and Visual3D were used to collect side-step cutting and analyze the biomechanical variables. The results indicated soccer players had greater ankle plantar flexion and hip abduction angle at the foot contact. The soccer players also had greater peak knee flexion and internal rotation angle, hip adductor moment, while basketball players had greater peak braking GRF and the peak vertical GRF during cutting. It is concluded that basketball and soccer players demonstrate differences in neuromuscular control patterns during sidestep cutting tasks.

KEYWORDS: ankle angle, knee internal rotation, ACL

INTRODUCTION: Most knee sprains are associated with anterior cruciate ligament (ACL) injuries. In the United States between the ages of 15 and 25, approximately 80,000 to 250,000 people experience ACL injuries each year (Flynn et al., 2005), and most ACL injuries occur on the sports field. The ACL provides knee joint stability, prevents the femur from slipping forward, and restricts the rotation of the humerus. Therefore, it can cause abnormal knee movement after injury, and even cause damage to soft tissue around the knee joint.
The soccer and basketball have different rules, equipment, and training modes, but all need to be fast and sprint conversion offensive and defensive skills. (Bradley et al., 2009; McInnes, Carlson, Jones, & McKenna, 1995). The two popular sports have a high risk of non-contact ACL knee injury. Agel et al. (2007) and Dick et al. (2007) found that the number of female ACL injuries in basketball and soccer players between 1990 and 2002 was 3.59 and 2.78 times that of men. The number of non-contact ACL injuries among female basketball (1722) and soccer players (1301) was 305 (17.7%) and 161 (12.4%) (Agel et al., 2005), showing female athletes have a high risk of ACL injury.
Sidestep cutting is an important skill in basketball and football. It requires instantaneous deceleration support and uses the lower limbs to ease the impact and quickly change direction to evade the defensive player. In a competition, the movement that suddenly changes direction in a straight line is common skill, but it also increases the risk of knee injury in athletes (Malinzak, Colby, Kirkendall, Yu, & Garrett, 2001). Many studies have pointed out that side step cutting has a higher risk of non-contact ACL injury (Cochrane, Lloyd, Buttfield, Seward, & McGivern, 2007; Cowley, Ford, Myer, Kernozek, & Hewett, 2006; Pollard, Stearns, Hayes, & Heiderscheit, 2015). The factors associated with ACL injuries, such as large knee valgus, valgus moment, Internal-rotation moment, and abduction, are often risk factors for predicting ACL injury (McLEAN, Neal, Myers, & Walters, 1999; Pollard, Sigward, & Powers, 2007).
Many studies indicated that the risk of ACL injury could be reduced by neuromuscular training (Hewett, Myer, & Ford, 2004; Myer, Ford, PALUMBO, & Hewett, 2005), however, there is still a high rate of ACL injury in female athletes each year especially on soccer and basketball sports (Agel et al., 2007; Dick et al., 2007). The high rate of ACL injury on female basketball and cocker players is unclear. Therefore, the purpose of this study is to investigate the effect of female basketball and soccer players perform sidestep cutting on the biomechanics of lower extremities. The results can provide to coaches and players to reduce knee injuries during basketball and soccer training and competition.

METHODS: Twenty soccer and female basketball players were recruited. (10 basketball: height 173.2±6.5 cm, weight 67.4±8.1 kg, age 19.9±1.3 years old; 10 soccer: height 160.8±5.7 cm, weight 55.5 ±4.1 kg, age 19.9 ± 1.3 years), and training for more than five years. Ethical approval was obtained from the University Joint Institutional Review Board. The participants filled out the consent form and basic data and warm-up on the Treadmill (6m/s) for 5 minutes. Twenty-six reflective markers were attached to the body landmarks which modeling both hip, thigh, knee, leg, ankle, foot, and toe. Ten Vicon cameras (MX13+ 250Hz) synchronized with a force plate (Kistler 9281,1000Hz) to collect the side-step cutting. The participants are prepared at a distance of 5 meters to the center of the force plate. A defender was starting at the defensive distance one meter behind the force plate with feet to open and shoulder width knees slightly flexed, and the hands were slightly placed on the side of the body for the uniform defensive movement. After starting signal, the participate sprinted as fast as possible then use the right (dominant) foot contact the force plate, then use the left foot side cut to the left about 45 degrees. After cutting out, run as many steps as possible to simulate the game situation (McLean et al., 2004). Five successful trails for each participant were collected for the biomechanical analysis.
The markers data were smoothed by 6 Hz Butterworth 4th order low-pass filter and calculated by Visual3D software. The kinematic variables include the hip, knee, ankle angle at initial contact, peak and ROM of knee and ankle angle at contact phase, support time and peak GRF and moment of lower extremities. The inverse dynamics combine the Dempster parameters (Dempster, 1955) to calculate the net moment of each joint (Davis, Ounpuu, Tyburski, & Gage, 1991; Winter, 2009).
The biomechanical differences between soccer and basketball players were statistically tested by the independent t-test using SPSS for Windows 20.0 software, with a significant level of α=.05.

RESULTS: No difference was found on COM velocity at initial contact between basketball (3.02 m/s) and soccer players (2.99 m/s). The soccer players have a larger ankle plantarflexion and hip abduction angle than the basketball players at touchdown. (Table1) Compared with the female basketball player, the soccer players have greater peak ankle eversion, knee flexion and internal rotation angle than those of the basketball player. (Table 2) The soccer players also have a greater ROM of knee flexion and internal rotation angle. For the kinetics, the soccer player has longer support and braking time, a larger peak braking GRF, and a greater vertical peak GRF, while the basketball player has a large propulsive peak GRF (Table 3). The soccer player has a larger peak ankle external rotation and hip adductor moment and the basketball player has a larger peak ankle plantarflexion moment during the cutting (Table 4).

Table 1. Hip, knee, and ankle angles of sidestep cutting at touchdown

	basketball	soccer
Ankle (deg)		
Plantarflexion*	15.96 ± 5.79	28.91 ± 8.06*
Eversion	2.43 ± 5.61	5.22 ± 6.76
External rotation	22.18 ± 6.28	21.39 ± 4.74
Knee (deg)		
Flexion	28.77 ± 8.75	23.47 ± 5.52
Abduction	3.77 ± 4.14	1.60 ± 2.82
External rotation	6.00 ± 4.61	7.18 ± 3.92
Hip (deg)		
Flexion	49.87 ± 9.79	54.69 ± 7.59
Adduction*	3.65 ± 6.56	11.78 ± 4.65*
Internal rotation	10.43 ± 14.08	9.79 ± 12.61

* p<.05

Table 2. Peak Knee and Ankle angle and Knee ROM during sidestep cutting

	basketball	soccer
Ankle (deg)		
Dorsiflexion	11.18 ± 6.85	6.28 ± 2.86
Eversion*	11.61 ± 5.38	18.54 ± 5.48*
External rotation	27.43 ± 5.88	27.17 ± 4.16
Knee (deg)		
Flexion*	53.80 ± 5.60	58.31 ± 2.97*
Abduction	3.72 ± 6.00	1.03 ± 3.62
Internal rotation	1.37 ± 5.19	8.13 ± 5.14*
Knee ROM (deg)		
Flexion*	25.03 ± 7.01	34.84 ± 4.64*
Abduction	3.64 ± 1.98	2.64 ± 1.38
Internal rotation*	8.35 ± 4.48	15.31 ± 3.04*

* p<.05

Table 3. Support time and peak GRF of sidestep cutting

	basketball	soccer
Support time (s)		
Total*	0.20 ± 0.01	0.24 ± 0.02*
Braking*	0.13 ± 0.01	0.16 ± 0.01*
Propulsive	0.07 ± 0.01	0.08 ± 0.01
Antero-posterior (BW)		
Braking 1st peak*	0.94 ± 0.18	1.21 ± 0.35*
Brake 2nd peak*	0.85 ± 0.18	1.15 ± 0.27*
Propulsive peak*	0.35 ± 0.08	0.22 ± 0.05*
Vertical (BW)		
Peak 1*	2.76 ± 0.33	3.59 ± 0.66*

* p<.05

Table 4. Peak ankle and hip moment during side-step cutting

	basketball	soccer
Ankle (Nm/kg/m)		
Plantarflexion*	1.97 ± 0.32	1.71 ± 0.11*
Eversion	0.22 ± 0.11	0.26 ± 0.11
External rotation*	0.13 ± 0.12	0.26 ± 0.09*
Hip (Nm/kg/m)		
Adductor (Nm/kg/m)*	0.11 ± 0.24	0.46 ± 0.15*
External (Nm/kg/m)	0.46 ± 0.27	0.57 ± 0.17

* p<.05

DISCUSSION:
This study found that soccer players have a greater ankle plantarflexion angle than the basketball player at the initial contact of side-step landing. This may due to the design of soccer shoe concentrates the stud part on the forefoot part to run and to change direction quickly on a softer and slippery grass. (Speer, 1992); however, the greater angle of forefoot touchdown and quick change of direction may be related to the mechanisms that cause knee ACL injury (Pace et al., 2015). The larger ankle eversion angle at contact cause larger vertical peak GRF and braking peak GRF than the basketball players. (Yu, Lin, & Garrett, 2006); also, the excessive ankle eversion angle of the soccer players during cutting (Table 2) may increase the knee internal rotation angle (Alentorn-Geli et al., 2009; Hewett, Myer, & Ford, 2006), which may increase the rate of ACL injury. The basketball players have a greater propulsive peak GRF (Table 3) which related to greater plantarflexion moment during the cutting than the soccer players (Table 4). The soccer players have a greater knee

internal rotation angle resulting in a higher ankle external rotation moment at sidestep cutting than the basketball players.

The soccer player has a larger hip abduction angle (Table 1) produces a large hip joint adduction moment (Table 4) than the basketball player at sidestep cutting. Previous studies indicated that excessive hip adduction moment increases the knee valgus moment (Ford, Myer, & Hewett, 2003; Hewett et al., 2005), which is also responsible for the increase in ACL load. The soccer player has greater lower extremities angles, forces and moments than the basketball players during the sidestep cutting may due to the soccer players have more sidestep cutting than the basketball players during practices and competitions. Our findings indicated that basketball and soccer players would demonstrate differences in neuromuscular control patterns during sidestep cutting tasks.

CONCLUSION: The purpose of this study was to investigate the effect of female basketball and soccer players perform sidestep cutting on the biomechanics of low extremities. Female soccer players were generating a large ground reaction force and increasing the knee flexion angle during sidestep. It was concluded that basketball and soccer players would demonstrate differences in biomechanical patterns during sidestep cutting tasks. It recommend that female basketball and soccer players should strengthen knee-related muscular training to reduce the injury.

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