MECHANISMS OF ANTERIOR CRUCIATE LIGAMENT INJURY IN BADMINTON PLAYERS
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INTRODUCTION:
Non-contact anterior cruciate ligament (ACL) injuries frequently occur in sports requiring landing from a jump or pivoting, such as seen in playing basketball and soccer. Recent research has focused on analyzing biomechanical factors of the high risk maneuvers considered to be associated with ACL injury, and excessive knee valgus has been reported to be a risk factor [1]. Competitive badminton also requires these maneuvers, and there are many incidents of ACL injuries, but little attention has been paid them. Badminton differs from other sports in that it is a noncontact sport and a racket is used. Players require distinctive and quick footwork, and after an overhead stroke, they tend to land on their left leg in the case of right-handed players. According to the information from players injured in badminton, about half of them were injured during single leg landing after an overhead stroke following a backward step. There has been no biomechanical analysis of the movement contributing to this loading pattern. For the prevention of ACL injuries, it is important to study the sports-specific characteristics. The purpose of this study was to investigate the knee kinematics and kinetics during single leg landing after an overhead stroke following back step, a movement linked to ACL injury in badminton players, and compare these by the differences in the backward step direction.

METHODS:
Seven male (mean age, 19.6±1.3 years-old) and five female (mean age, 19.6±1.8 years-old) right-handed college badminton players with no past history of knee injury participated in this study. Subjects performed two or three backward steps diagonally towards the right and the same towards the left (Figure 1), landing on their left leg immediately after making an overhead stroke with racket on their right hand. For each subject, sixteen retroreflective markers were placed on anatomical landmarks. Trials were collected with a three dimensional motion analysis system (Vicon) with 7 infrared cameras and four force plates (AMTI). The angle of the knee at initial contact (IC) and maximum knee flexion (MKF) were determined respectively. Maximum knee moments from IC to Max were measured and these were normalized to height and body weight. To compare the data of backward steps toward the right and left, paired t test with a significance levels 0.05 was used.

RESULTS:
In males, the knee varus/valgus angle at IC was varus 8.1±4.1° at the right backward step, and valgus 4.5±6.9° at the left backward step, while at MKF, it was varus 7.8±10.1° and varus 1.9±11.8°. In females, the knee varus/valgus angle at IC was varus 6.5±6.1° at the right backward step, and varus 1.1±5.2° at the left backward step, while at MKF, it was varus 5.3±11.9° and valgus 4.5±12.0° (Table 1). The knee valgus angles at MKF were significantly larger at the left backward step both in males and females (p<0.05). In males, maximum knee valgus moment was 1.0±4.0 Nm/kg/m at the right backward step and it was 3.1±6.2 Nm/kg/m at left backward step. In female, it was 5.1±4.2 Nm/kg/m and 7.3±5.1 Nm/kg/m. Players showed larger knee valgus moments at the left backward step than at the right backward step both in males and females, but there was no significant difference (Table 2).

DISCUSSION:
The results of this study demonstrated that knee kinematics was different depending on step direction. Knee valgus angle during single leg landing after overhead stroke following the left backward step were larger than the right backward step. This might be related to the numerous ACL injuries occurring during single leg landing after an overhead stroke at the left rear of the court. For the prevention of ACL injury, it is suggested that understanding the “at risk” posture and adaptation of training methods to teach landing technique considering sports-specific movement may be needed.