FATIGUE INDUCED BY REPEATED TURNS PRODUCES KINEMATIC CHANGES IN FEMALE SOCCER PLAYERS

BERTOZZI, F.1, ZAGO, M.2,3, ANDREOLETTI, S.4, AVALLONE, N.4, BRUNETTI, C.2, RABELLO, R.1, GALVANI, C.4, GALLI, M.2,3, SFORZA, C.1

1 UNIVERSITÀ DEGLI STUDI DI MILANO, MILAN, ITALY; 2 POLITECNICO DI MILANO, MILAN, ITALY; 3 E4SPORT LAB, POLITECNICO DI MILANO, ITALY; 4 UNIVERSITÀ CATTOLICA DEL SACRO CUORE, MILAN, ITALY

INTRODUCTION:
The incidence of Anterior Cruciate Ligament (ACL) injury in female athletes is still remarkable (1). In particular, soccer has one of the highest ACL frequency and female athletes are 2 to 3 times more likely to get injured than men (1). Nearly 80% of all ACL injuries are due to non-contact mechanism and occur during landing, pivoting or cutting maneuvers (2). ACL injury is multifactorial, but modifiable risk factors may include abnormal cutting patterns due to fatigue (3,4). However, the extent to which fatigue alters movement mechanics is still unclear (4,5). A better understanding of the influence of fatigue on these mechanisms would enhance the development of prevention programs.
METHODS:
Nine élite female soccer players (age: 20-31 years, BMI: 18.4-22.7 k gm-2) playing in the first or second Italian division ("Serie A" and "B") performed a 5-m shuttle-run test until exhaustion, paced at 70% of their maximal aerobic speed (2.6±0.2 m s-1).
The three-dimensional position of 37 reflective markers during the test was obtained with an optoelectronic motion analysis system (BTS, Italy). Peak blood lactate concentration was measured at the end of the test. A biomechanical model was developed in Visual 3D (C-Motion, USA) to obtain hip, knee and ankle 3D kinematics. Statistical parametric mapping (paired t-tests) were used to compare joint kinematics during the stance phase between the turns 6-10 and the last 5 turns executed with the preferred leg.
RESULTS:
The post-exercise peak of blood lactate concentration was 10.7±3.0 mM. The hip was more extended at mid-stance ($t=2.398$, $p=0.038$), as well as the knee ($t=2.635$, $p=0.005$). The tibia was more internally rotated from 20% to 80% of the stance phase ($t=2.677$, $p<0.001$). No significant differences were observed for the ankle joint.
CONCLUSION:
Results highlighted a sequence of movement alterations related to biomechanical risk factors for ACL injury (2). Knee and hip flexion were reduced, while we observed an increased tibial internal rotation and knee dynamic valgus. No alterations occurred in knee kinematics on the frontal plane: likely, the difference between the fresh and the fatigued condition was not sufficiently demanding to cause this pattern alteration. However, the baseline value (10-15 degrees of knee abduction) could be potentially hazardous per se, even before the onset of fatigue.
Following the findings of our recent work on male athletes (3), it is confirmed that fatigue can be a part of the multifactorial scenario in which ACL injuries occur. Given also the higher incidence in women, the implementation of specific neuromuscular training when players are fatigued can provide significant benefits, moderating modifiable biomechanical risk factors.
REFERENCES