AGE DIFFERENCES IN RISK FACTORS OF NONCONTACT ANTERIOR CRUCIATE LIGAMENT INJURY CAUSED BY NEUROMUSCULAR FATIGUE

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INTRODUCTION

Anterior cruciate ligament (ACL) injuries are among the most common knee injuries in sports.[1] Female athletes have a higher incidence of noncontact ACL injuries than do their male counterparts.[2] Neuromuscular fatigue has been suggested as an extrinsic factor in the mechanism of noncontact anterior cruciate ligament injury in both genders.[3]

The purpose of this study was to determine the risk factors of noncontact anterior cruciate ligament caused by neuromuscular fatigue during the box drop vertical jump and compare changes between ages in female recreational athletes.

METHODS

Three-dimensional motion analysis, force plate, and electromyography data were collected for 33 female recreational athletes (7~9yrs: 11, 14~16yrs: 11, 22~24yrs: 11) performing a box drop vertical jump task before and after completing a fatigue exercise.

The subject was instructed to drop off the box (knee joint height of each subject), leave with both feet at the same time, land, and then immediately perform a maximum vertical jump. The fatigue exercise consisted of repetitions of 5 consecutive vertical jumps followed by a 30-m sprint until complete exhaustion.[1]

A repeated measures analysis of variance (fatigue * age) was performed on the biomechanical risk factors of noncontact ACL injuries.

RESULTS AND DISCUSSION

Neuromuscular fatigue caused female recreational athletes to land with more hip flexion (main effect fatigue, $P = .005$; main effect age, $P = .015$; fatigue*age, $P = .403$), knee flexion (main effect fatigue, $P = .003$; main effect age, $P = .037$; fatigue*age, $P = .534$), knee valgus angles (main effect fatigue, $P = .025$; main effect age, $P = .048$; fatigue*age, $P = .634$), and H-Q ratio (main effect fatigue, $P = .031$; main effect age, $P = .025$; fatigue*age, $P = .321$). 14~16yrs female recreational athletes exhibited greater peak hip flexion, valgus angles, and H-Q ratio postfatigue. Female recreational athletes exhibited lower knee extension moments (main effect fatigue, $P = .039$; main effect age, $P = .041$; fatigue*age, $P = .147$) and knee valgus moments (main effect fatigue, $P = .042$; main effect age, $P = .036$; fatigue*age, $P = .235$). 14~16yrs female recreational athletes exhibited lower knee flexion angle, knee extension moment and valgus moments postfatigue.

An understanding of fatigue and age effects on the biomechanical risk factors of noncontact ACL injuries may provide significant information for the development of prevention programs for noncontact ACL injuries.

CONCLUSIONS

Neuromuscular fatigue caused significant alterations in female recreational athletes, especially 14~16yrs, that may be indicative of the noncontact ACL injury mechanisms. Current noncontact ACL prevention programs should incorporate a fatigue component to help minimize the deleterious effects of neuromuscular fatigue on landing mechanics.

REFERENCES

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Table 1: The risk factors of noncontact ACL injuries based on state of fatigue and age

Variables	7~9yrs		14~16yrs		22~24yrs	
	before	**after**	**before**	**after**	**before**	**after**
Hip Flexion Angle	43.56 ± 11.75	47.53 ± 12.86*	44.57 ± 10.75	51.42 ± 15.21*	41.08 ± 8.65	49.54 ± 16.17*
Knee Flexion Angle	60.75 ± 11.51	66.87 ± 13.87*	59.75±8.57	65.48 ± 9.75*	62.85±7.86	67.25 ± 8.42*
Knee Valgus Angle	4.01 ± 5.37	5.37 ± 5.64*	4.12 ± 5.18	6.67 ±5.31*	3.91 ± 4.50	5.42 ± 5.21*
Extension Moment	1.50 ± 0.64	1.26 ± 0.39	1.49 ± 0.68	1.22 ± 0.40*	1.51 ± 0.70	1.24 ± 0.42
Valgus Moment	1.68 ± 0.47	1.08 ± 0.49	1.57 ± 0.51	1.07 ± 0.53*	1.66 ± 0.46	1.09 ± 0.51
H-Q Ratio (%)†	66.85 ± 5.84	74.84 ± 6.24*	68.51 ± 5.28	77.84 ±6.37*	65.86 ± 4.78	75.24 ± 5.34*

†H-Q (Hamstring-Quadriceps) Ratio (%) : [rectus femoris IEMG average / (biceps femoris IEMG average + rectus femoris IEMG average)] $\times$ 100
*p<.05