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THE CHANGE OF KNEE KINEMATICS AFTER ANTERIOR CRUCIATE LIGAMENT DEFICIENCY AND RECONSTRUCTION DURING LANDING

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The purpose of this study were to evaluate the different of knee kinematics analysis after ACLD and ACLR during landing performances. The participants were instructed to finish counter moment jump (CMJ) with arms free 5 times as hard as possible with Vicon motion system and two force platforms. The ACLD showed a significant less knee flexion degree at the peak vertical GRF compared with others. Our founding was similar to the present studies; the impulse during landing among three groups was almost the same, but the RF EMG showed lower after two ACL groups, especially in ACLD.

KEY WORDS: ACL reconstruction, Landing time, peak force, impulse

INTRODUCTION: According to the past sport injury reports, there are over 250,000 persons with anterior cruciate ligament (ACL) injuries and there are 23% in ACL injury of acute knee injuries in US cost 15 hundred million dollars (Boden, Griffin, & Garrett, 2000). The most common kinetic scenarios related with ACL injuries are internal twisting of the tibia relative to the femur or combined torque and compression during a hard landing (Hootman, & Dick, 2007). The previous biomechanics kinematics studies indicated that knee joint would be changed after ACL reconstruction including gait, joint glide, valgus-varus knee (Ferber, Osternig, Woollacott, Wasielewski, & Lee, 2002), anterior shift and internal-external rotation angle of tibia (Chaudhari, Briant, Bevill, Koo, & Andriacchi, 2008).

Most of tests are used to evaluate the recovery of surgery if good enough to return to sports, such as Lachman test, isokinetic muscle strength test and joint stability test. But that still can’t exhibit the muscle and joint condition when exercise. Approximately 91% of ACL injuries occur during sporting activities, usually from a non-contact event and cutting or one-legged landing movement (Koga, Nakamae, Shima, Iwasa, Myklebust, Engebretsen, Bahr, & Krosshaug,2010). The walking gait and landing strategy and adaptations would be changed after ACL injuried and reconstruction (ACLR).In 2007, Reid found the functional jump tests could be used as the clinical index to evaluate the recovery of ACL deficiency (ACLD), such as front hop or side hop. A number of studies showed the vertical ground reaction force (GRF) pattern is different after ACLD. The purpose of this study were to evaluate the different of knee kinematics analysis after ACLD and ACLR during landing performances.

METHODS: Eighteen males and twelve females volunteered for this study (Table 1). Thirty participants kept in joining sports without pain or uncomfortable. There were six males and four females in the healthy group and the same as ACLD and ACLR groups. The ACLD knees were judged based on orthopedist or MRI at least grade II, they all did exercise and work normally and the average history was 3.59 years. The ACLR knees were back to sports or life after 6-monthes surgery at least, the average was 1.93 years. This study was approved by the National Taiwan Sports University Institutional Review Board. Before joining this study, all the participants need to read and sign the written informed consent.

Table 1. The database of all the participants

	Age (years)	Height (cm)	Weight (kg)
Healthy	21.70 ±3.92*	171.20 ± 9.60	65.30 ±10.98
ACLD	26.90 ±1.90*	171.80 ± 6.43	67.50 ± 8.83
ACLR	22.30 ±3.83*	170.80 ±10.34	70.10 ±20.00

*p<.05

The instrumentation included Vicon T40 motion analysis system with ten infrared cameras was used to capture the 3-D trajectories of the reflective markers attached on the subject's segments with sampling rate 100 Hz. A force platform was sampled the ground reaction force (GRF) and kinematic data during landing at 1000Hz.

All the tests were done in Laboratory of Technology of Sport in National Taiwan Sports University. Before start to the test, each participant had to record his/her age, height, weight and do 10 minutes cycling worm up and stretch. Then, 13 reflective markers were placed on dominant, deficiency or reconstruction side of participants. The participants were instructed to finish counter moment jump (CMJ) with arms free 5 times as hard as possible after practicing 2-3 times. They started and landed upon a force platform one leg, and try to hold their bodies until stabilization. Data were collected synchronically.

Raw signals were recorded from the instrumentations, and data were interpreted by Euler angle by Matlab (The Mathworks Inc., Natick, USA). The knee joint angle included the angle at the peak GRF when landing and changed from initial contact to peak GRF, and the straight knee when standing was the reference defined as zero degree angle. Time and impulse were counted from initial ground contact to peak GRF also. The landing force was scaled of the peak GRF to body weight (%BW) to reduce within and between groups differences. The landing energy production from joint and muscle defined as the impact phase within the first 100 ms contact (Decker, Torry, Wyland, & Sterett, 2003), mean the impact impulse also.

The means and standard error (SE) were used for all analyses. The values were averaged across the 5 trials of 30 participants. One-way ANOVA of SPSS version 13.0 was used to compare the variables of three groups, and Tukey *post hoc* comparison was to determine specific differences when appropriate. The level of significance was set at .05.

RESULTS: The collected data of kinematic was showed as table 2. Most of the data were no significant difference besides knee flexion-extension angle when peak landing force among three groups. ACLD had smaller angles then other groups significantly (p<.05).

Table 2. All the data of kinematic during healthy, ACLD and ACLR

		Healthy(n=10)	ACLD (n=10)	ACLR(n=10)
	GRF (%BW)	3.26 ±0.15	2.99 ±0.13	3.23 ±0.22
	Peak GRF	16.95 ±3.97*	7.41 ±3.53*	29.03 ±7.40*
Knee joint angles	Landing to peak	15.94 ±4.77	12.68 ±5.62	8.66 ±3.19
(deg)	Time to peak (sec)	0.16 ±0.06	0.09 ±0.01	0.09 ±0.01
Impulse	Landing to peak	0.14 ±0.01	0.14 ±0.01	0.13 ±0.01
(N · s)	Landing to 100 ms	0.18 ±0.01	0.16 ±0.01	0.16 ±0.13

*p<.05

DISCUSSION: The ACLD showed a significant less knee flexion degree at the peak vertical GRF compared with others. Hewett et al (2005) found some difference when jump landing.

Their study pointed out the ACL injured groups with lower knee flexion angles at peak contact. Landing stiffness was usefully defined as soft- and stiff-landing techniques with the knee flexion position (Decker, Torry, Noonan, & Sterett, 2002). The knee flexion angles of ACLD had the similar less flexion angles then others to previous study and might be more stiff when landed to ground. The participants might to avoid the “giving away” feeling, so they were afraid to landing with large flexion angles. The knee flexion angles of ACLR at peak GRF were no significant difference higher then healthy, but the larger angles might display the change after ACLR to do more cushion of knee flexion angles.

The landing time often divided as initial contact, time to peak GRF and the descend phase (stable phase). But the first tibia internal rotation was occurred within 40 milliseconds (ms) during landing and the energy absorption have assessed as landing impulse only the early phase, commonly defined as the first 100 ms after ground contact (impact phase). The impulse of landing to peak GRF and landing to 100 ms were both no significant difference among three groups. That means there were similar. Kulas et al (2006) thought that the landing energy absorption at impact phase were knee and ankle almost, and hip and knee were the main role to absorb the energy during stabilization phase. Although the knee flexion angles from landing to peak GRF were no significant differences either, the changed angles of ACLR were smaller then others. The time from landing to peak GRF of ACLD and ACLR were almost the same, the less changed of knee flexion-extension angles, the larger energy would be loaded to knee joint immediately. That mean this condition would like a stiff knee landing strategy after ACLR in our study.

CONCLUSIONS: Our founding was similar to the present studies; the impulse during landing among three groups was almost the same, but the RF EMG showed lower after two ACL groups, especially in ACLD.

REFERENCES:

Boden, B., Griffin, L., & Garrett, W. (2000). Etiology and prevention of noncontact ACL injury. *The Physician and Sportsmedicine., 28*, 1-14.

Chaudhari, M.W., Briant, P.L., Bevill, S.L., Koo, S., & Andriacchi, T.P. (2008). Knee kinematics, Cartilage morphology, and ostroarthritis after ACL injury. *Medicine and Science in Sport and Exercise*, 40(2), 215-222.

Decker, M.J., Torry, M.R., Noonan, T.J., Amy, R., & Sterett, W.I. (2002). Landing adaptations after ACL reconstruction. *Medicine and Science in Sport and Exercise*, 34(9), 1408-1413.

Decker, M.J., Torry, M.R., Wyland, D.J., & Sterett, W.I. (2003). Gender differences in lower extremity kinematics, kinetics and energy absorption during landing. *Clinical Biomechanics*, 18, 662-669.

Ferber, R., Osternig, L.R., Woollacott, M.H., Wasielewski, N.J., & Lee, J.H. (2002). Gait mechanics in chronic ACL deficiency and subsequent repair. *Clinical Biomechanics, 17*, 274-285.

Freeman, M.A.R., & Pinskerova, V. (2005). The Movement of the normal tibio-femoral joint. *Journal of Biomechanics, 38*, 197-208.

Hootman, J.M., & Dick, J.A. (2007). Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. *J Athl Train*, 42(2), 311–319.

Koga, H., Nakamae, A., Shima, Y., Iwasa, J., Myklebust, G., Engebretsen, L., Bahr, R., & Krosshaug, T. (2010). Knee joint kinematics in 10 injury situations from female team handball and basketball. *The American J of Sport Medicine*, 38(11), 2218-2225.

Kulas, A.S., Schmitz, R.J., Shultz, S.J., Watson, M.A., & Perrin, D.H. (2006). Energy absorption as a predictor of leg impedance in highly trained females. *Human Kinetics*, 22, 177-185.

Simonsen, E.B., Magnusson, S.P., Bencke, J., Nasborg, H., Havkrog, M., Ebstrup, J.F., & Sorensen, H. (2000). Can the hamstring muscles protect the anterior cruciate ligament during a side-cutting maneuver? *Scand Journal of Medicine Science & Sports*, *10*, 78-84.

Hewett, T.E., Myer, G.D., & Ford, K.R. (2005). Biomechanical measures of neuromuscular control and valgus loading of the knee predict anterior cruciate ligament injury risk in female: a prospective study. *Am J Sports Med*, 33(4), 492-501.