EFFECTS OF FUNCTIONAL KNEE BRACE ON LOWER EXTREMITY MUSCLE ACTIVATIONS AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

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The purpose of this study was to analyze effects of functional knee brace on muscular activation of lower extremity for the ACLR athletes during single leg drop landing. Marker trajectories, ground reaction forces and EMG signals were collected and synchronized by Vicon Nexus software. Mann-Whitney U test was used to compare muscle activations of ACLR athletes when wearing knee brace verses no knee brace, and the significance level was set at $\alpha = .05$. The results showed that the GM, RF and BF muscle activation levels were significant increased when wearing knee brace than no knee brace at single-leg drop jump. Wearing knee brace for ACLR athletes can help to increase activation of knee flexors and help to stabilize knee joint during dynamic situation. We suggest that knee brace could help ACLR athlete to maintain better knee stability.

KEY WORDS: acl reconstruction, knee brace, EMG

INTRODUCTION: Team sports, such as soccer, basketball, handball and rugby, are often required to perform sudden-deceleration, dodge an opponent and changes direction of centre of mass. However, non-contact anterior cruciate ligament (ACL) injuries are often occurred at these types of sports (Besier, Lloyd, & Ackland, 2003; Kim et al., 2014; Nagano, Ida, Akai, & Fukubayashi, 2011; Suzuki, Ae, Takenaka, & Fujii, 2014). Previous studies have indicated that athletes with reconstructed ACL still have some limitation regarding to their functional activities or lower extremity neuromuscular control (Ortiz, Olson, Libby, Trudelle-Jackson, Kwon, Etnyre, & Bartlett, 2008). In addition, Kim et al., 2014 reported that athletes with ACL reconstruction (ACLR) have displayed smaller hip and knee joints flexion, adduction and internal rotation, as well as have larger internal rotation and external rotation in both of the hip and knee joints when compared to healthy athletes. Additionally, ACLR athletes demonstrated increased knee extension and valgus moment, as well as increased glutes maximum and rectus femoris muscle activations, and decreased hamstring muscles activations during single leg drop landing. However, ACLR athletes did have a smaller anterior shear force than healthy control during single leg drop landing. Studies have shown that knee braces could help to enhance muscle activations around knee joints and reduce tibial translations up to 85% for healthy athletes (Wojtys, Kothari, & Huston, 1996). However, effects of knee brace on ACLR athletes during functional activities are still unknown. Therefore, the purpose of this study was to analyze how the functional knee brace would affect lower extremity muscle activations of ACLR athletes.

METHODS: 10 athletes (five males and five females) with a history of unilateral ACLR (R and L-side Reconstruction: 5, respectively; Age: 22.4±1.0 yrs; Height: 169.4±8.6cm; Body Weight: 65.6±10.7kg; Surgery time since experiment: 24.5±16.3months) were recruited for this study. There were 27 reflective markers placed on subjects and a 13 link segment model was created in this study. Marker trajectories were collected using a 10-camera motion analysis system (VICON, UK) at a sampling rate of 200 Hz with a force plate (Kistler, Switzerland) to collect the ground reaction force at a sampling rate of 1000 Hz. In addition, the wireless surface EMG (Delsys Inc., Boston, MA, USA) with sampling rate at 1000Hz were placed on gluteus medius(GM), rectus femoris (RF), vastus medialis (VM), vastus lateralis (VL), biceps femoris (BF), semitendinosus (ST)、medial gastrocnemius (MG) and tibialis anterior (TA) of ACLR limb. All data were synchronization by Vicon Nexus 1.8.2 software during data collection. Subjects were asked to stand on the 30 cm height box and performed a single-leg drop landing; and three successful trials were collected. A DonJoy armor ACL

knee brace was wore as the experimental condition to compare with no knee brace condition for ACLR athletes. The raw EMG signals were band-pass filtered between 10-480 Hz, rectified, and smoothed by root mean square at 30 ms window by using the AcqKnowledge software (Biopac USA Inc). Then, EMG signals were normalized by the peak amplitude during the dynamic task. Averaged EMG signals from specific phases were used for data analysis. The landing motion was divided into 4 phases, which were pre-activation (from 50ms before foot strike to foot strike), landing (from foot strike to peak GRF), peak push-off (10ms either side of the peak GRF), and final push-off phases (from peak GRF to foot take off) through the vertical ground reaction force. (Besier et al., 2003; Hanson, Padua, Blackburn, Prentice, & Hirth, 2008). Nonparametric test (Wilcoxon signed ranks) was used to compare muscle activations of ACLR athletes when wearing knee brace verses no knee brace ($\alpha = .05$).

RESULTS: Before landing (Figure 1-A), the pre-activation level of GM was significant greater when wearing knee brace ($p<.05$), but ST was significant greater without knee brace ($p<.05$). At the initial landing from drop jump (Figure 1-B), BF muscle activation of knee brace condition was significant greater than no brace condition ($p<.05$). At the peak push-off, GM muscle activation was significant greater when wearing knee brace ($p<.05$). At the final push-off (Figure 1-D), RF mucles activation was significantly greater in knee brace condition than without knee brace ($p<.05$), but MG muscle activation was significant lesser than no knee brace condition ($p<.05$).

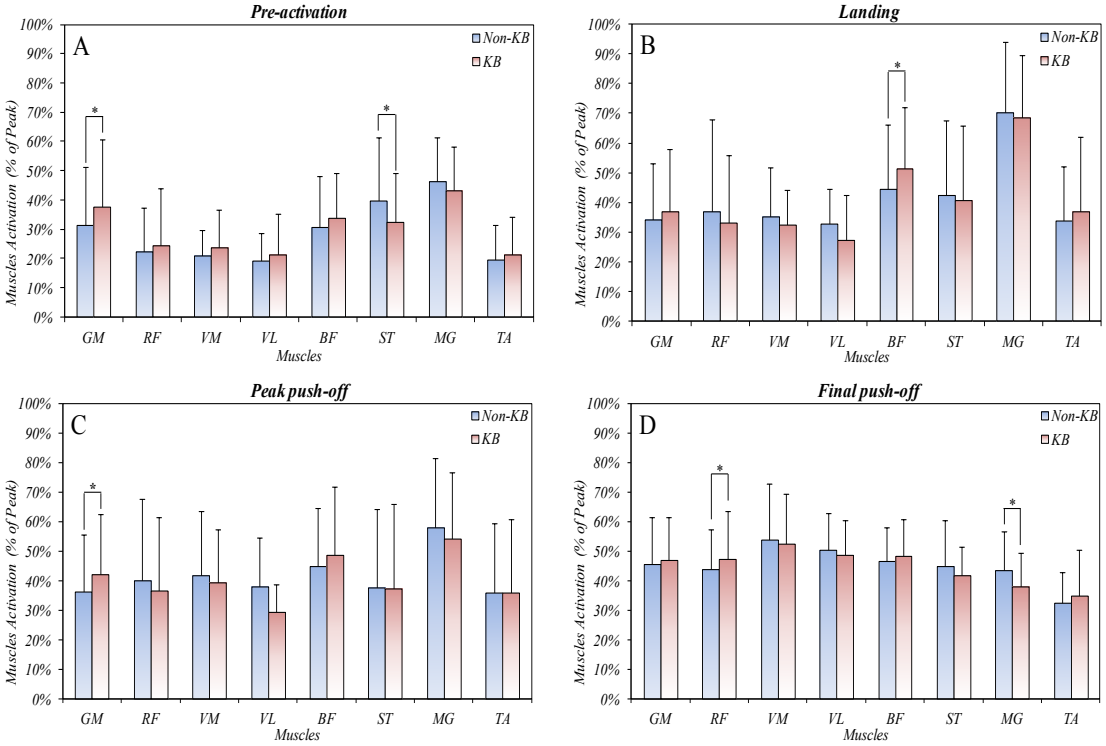

Figure 1: The four phases during a single-leg drop jump.

DISCUSSION: The pre-activation of the lower extremity muscle before landing is a compensatory mechanism which could help knee joint to maintain stability (Nagano et al., 2011). Results from the current study have shown that wearing knee brace could enhance GM and BF muscle activation levels at the pre-activation phase of ACLR athletes. In addition, the increased pre-activation and peak push-off of GM muscle activation could help to maintain pelvis stability and to reduce knee loading from drop jump landing. Kim et al. (2014) have addressed that excessive of quadriceps muscle activation during landing could result in increased knee shear force which could lead to potential ACL injury. When ACLR athletes

wore knee brace, the hamstring muscle activations were significant increased. The increased hamstring muscle activation could inhibit quadriceps muscle activation during landing, which could help to reduce anteiror knee shear force and help to cut down the re-injury rate.

CONCLUSION: Wearing knee brace for ACLR athletes can help to increase activation of knee flexors and help to stabilize knee joint during dynamic situation, and we suggest that knee brace could help ACLR athlete to maintain better knee stability.

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