THE ELECTROMYOGRAPHY CHARACTERISTICS BETWEEN DIFFERENT LEVELS OF SOCCER PLAYER ON INSTEP KICKING

Yo Chen[1], Wu-Yen Chang[2], Wen-Tien Yang[3] and Jia-Hao Chang[1*]

Department of Physical Education, National Taiwan Normal University, Taipei, Taiwan[1]
Department of Ball Sports, University of Taipei, Taipei, Taiwan[2]
Physical Education Office, Taipei Chengshih University of Science and Technology, Taipei, Taiwan[3]

This study improves kicking performance by comparing muscle activity between different levels of players. Twelve soccer players in the college cup in division I and division II volunteered to participate in this study. A VICON motion capture system (200 Hz) was used to capture the kicking motion including back-swing and forward-swing. The Noraxon electromyography system was used to collect and analyze the percentage of maximum voluntary contraction on rectus femoris, bicepsfemoris, tibialis anterior, and gastrocnemius. The Mann-Whitney *U* (α = .05) test was applied to assess significant differences in this study. The results indicated that division II players had a greater percentage maximum voluntary contraction in tibialis anterior in the back-swing. To avoid stiff movements in soccer kicks, division II players should decrease muscle contraction in the tibialis anterior in the back-swing.

KEY WORDS: Football, lower-extremity, muscle, shooting.

INTRODUCTION: Studies have demonstrated the kinematic characteristics of instep kicking and compared the kicking biomechanics in different levels of players (Lees and Nolan, 1998). Electromyography (EMG) activity has been used to understand the segment movement; and the percentage of maximum voluntary contraction (MVC) has been used to measure and normalize muscle activity. The movement of kicking has been separated into five phases as follows: preparation, run up, kicking leg back-swing, kicking leg forward-swing, and follow throw (Brophy et al., 2007). Scurr, Abott, and Ball (2011) measured the surface EMG of the vastus lateralis, vastusmedialis, and rectus femoris in the kicking leg back-swing and forward-swing, and the results indicated kicks to the right targets produced the greater muscle activity. A study that has compared the kicking ability between novice and skilled players has found the difference postures between the two groups (Shan and Westerhoff, 2005).The skills in kicking are complicated, and multiple factors must be measured. The purpose of this study was to identify the characteristics on muscle activity in elite players, and to improve kicking skills in division II players.

METHODS: Twelve players in the college cup division I (elite) and division II (sub-elite) volunteered to participate in this study (division I, n= 6, Aged: 22.1 ± 3.8 years, Height: 174.3 ± 6.8 cm, Body mass: 75.6 ± 14.3 kg, 11.3 ± 4.8 years' experience; division II, n=6, Aged: 25.0 ± 3.6 years, Height: 171.6 ± 5.9 cm, Body mass: 70.0 ± 9.1 kg, 7.5 ± 3.4 years' experience). The participants had no injuries within the last 6 months. Ethics approval was secured from the National Taiwan University Institutional Review Board and informed consent was obtained from the participants prior to data collection. A motion capture system with 10 cameras (VICON MX13^{+}, Oxford Metrics Ltd, England) was used to capture the kicking motion with a 200 Hz sampling rate. The Noraxon EMG system (Noraxon Inc. U.S.A) was used to measure the muscle activity on kicking leg with a 1500 Hz sampling rate, and sensors were applied on rectus femoris, biceps femoris, tibialis anterior, and gastrocnemius. The phases for measuring were the back-swing and forward-swing. A radar gun (Bushnell Ltd, USA) was used to measure the peak ball velocity (size 5, Pressure: 0.6 bar), and the foot switch was used to measure the time point of foot and ball contact. Participants were asked to kick a ball three times with maximal force instep kicks. The plug-in-gait marker setting was used to build a

full-body model. The MVC data were collected before the kicking test in four muscles, and the procedures used from operations manual of ACB of EMG (Konrad,2005). The data chosen to analyze was the data from the trial with the greatest ball velocity. The raw EMG was processed by band-pass (20-500 Hz), full-wave rectify and smoothing (root mean square, window length of 50 ms). The muscle activity was normalized in percentage MVC in the back-swing and forward-swing phases. The Mann-Whitney *U* test was applied to assess significant differences in this study ($\alpha = .05$).

RESULTS: Table(s) 1 and 2 shows the percentage of MVC on rectus femoris, biceps femoris, tibialis anterior, and gastrocnemius in back swing and forward swing phases. The greater percentage of MVC on tibialis anterior was found in division II players in the back-swing. The greater ball velocity was found in division I players (division I: 27.7 ± 2.6 m/s; division II: 21.7 ± 1.6 m/s).

Table 1
EMG activities in back swing

Unit: % MVC	Division I	Division II
Rectus femoris	18.8 ± 18.4	20.0 ± 13.2
Biceps femoris	96.5 ± 26.4	96.1 ± 6.4
Tibialis anterior *	16.5 ± 2.5	49.5 ± 25.8
Gastrocnemius	120.4 ± 35.8	118.5 ± 20.8

*Significant diffefence

Table 2
EMG activities in forward swing

Unit: % MVC	Division I	Division II
Rectus femoris	106.6 ± 31.7	115.3 ± 29.9
Biceps femoris	38.8 ± 22.0	32.1 ± 19.6
Tibialis anterior	72.1 ± 30.1	70.9 ± 13.7
Gastrocnemius	73.2 ± 40.6	82.3 ± 42.6

DISCUSSION: The similar muscle activity in the forward-swing during a kick was found in division I and II players. The difference in muscle activity was found on the tibialis anterior in the back-swing between levels of players. Lower muscle activity was found on the tibialis anterior in division I players. The greater muscle activity on the tibialis may cause the more dorsiflexion in the ankle joint, which results in the restriction of foot movement. To improve kicking performance, a previous study had analyzed the kicking kinematics and electromyography. Dorge et al. (2002) indicated knee angular velocity is the determining factor for kicking performance. Nunome et al. (2006) found that the different kicking motion was found in different levels of players. Scurr, Abott, and Ball (2011) indicated when the kick was to the right side, it produced greater muscle activity. In the present study, muscle activity was emphasized in the kicking performance. The greater EMG activity in the tibialis anterior may affect the movements in ankle joints and could result in stiff movement in the kicking motion. To improve the kicking performance, this study suggests that division II players should relax the muscle activity in the tibialis anterior during a kick.

CONCLUSION: The muscle activities in the lower-extremities in soccer kicking were analyzed in this study. The only difference was found in the tibialis anterior in the back-swing. To avoid stiff movement in soccer kicking, division II players should decrease the muscle contraction in the tibialis anterior in back-swings.

REFERENCES:

Brophy, R. H., Backus, S. I., Pansy, B. S., Lyman, S., & Williams, R. J. (2007) Lower extremity muscle activation and alignment during the soccer instep and side-foot kicks. *Journal of Orthopaedic & Sports Physical Therapy*, *37*(5), 260-268.

Konrad, P. (2005). The ABC of EMG. Scottsdale, AZ: Noraxon.

Lees & Nolan (1998). The biomechanics of soccer: A review. *Journal of SportsSciences, 16*(3), 221-234.

Nunome, H., Lake, M., Georgakis, A., & Stergioulas, L. K. (2006). Nunome H., Lake M., Georgakis A., and Stergioulas L. (2006). Impact phase kinematics of instep kicking in soccer. *Journal of Sports Sciences*, 24,11-22.

Scurr, Abott, and Ball (2011). Scurr, J. C., Abbott, V., and Ball, N. (2011). Quadriceps EMG muscle activation during accurate soccer instep kicking. *Journal of Sports Sciences, 29,* 247-251.

Shan and Westerhoff (2005). Full-body kinematic characteristics of the maximal instep soccer kick by male soccer players and parameters related to kick quality. *Sport biomechanics, 4*(1), 59-72.

Acknowledgement

This article was subsidized by the Ministry of Science and Technology, ROC.(MOST 103-2420-H-003-027-DR)