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PERFORMANCE EVALUATION APPROACHES IN HIGH LEVEL SPORTS

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Abstract. Muscular activation strategies or recruitment patterns are one of the hot topics in sport sciences. Researchers try to define specific muscular involvement patterns in a given sport branch and during execution of specific movement patterns. As chosen as one of the examples, archery release is very critical to reach high scores in sport archery. Especially, recurve archers use a device called clicker and as soon as its' snap against the bow handle archer needs to release the string. Three-finger hook opened by active contraction of extensor muscles or just relaxation of forearm flexors. Active contraction of forearm extensor muscles thought to create a lateral deflection of bowstring, which may decrease the score on the target. Like archery, soccer kick is also one of specific movement patterns that have been observed for muscular activation strategies. Lower extremity muscles play an important role in kick movement to stationary ball. Activation of Biceps Femoris and Gastrocnemius muscles found to be different than that of high level soccer players. So, reaching high-level sport performance needs to develop certain muscular activation or recruitment patterns. This review focuses on the specific muscular involvement strategies in given sports.

Keywords: kinesiologic electromyography (EMG), muscular recruitment, sport performance

Introduction. High-level sportive performance assessment may need numerous laboratory tests. One of the methods evaluates the neural procedures that effect the human movement [1]. In other words, muscular involvement or recruitment patterns are used as one of the most efficient approach to distinguish high-level athlete from the middle-class or beginners. As long as there are many other aspects of performance testing, evaluating the motor performance from neural and biomechanical aspects may supply important clues on the performance sub domains like strength, speed, endurance etc. Combining the sportive performance evaluation by using neural aspect with biomechanical applications may be named as Neuro-mechanical evaluation of human performance. Neuro-mechanical evaluation of motor abilities needs the synchronous usage of kinetic and kinematic aspects. Synchronization of these two methods forces the researchers to use superficial electromyography (EMG) instead of needle electrodes.

Kinesiologic electromyography (EMG), in very general saying, may supply information on neural drive. More specifically, one may evaluate the contraction/relaxation strategies used by agonist and antagonist muscles. Besides, co-contraction of agonist and synergist muscles may also be evaluated. When we combine the data from EMG with some kinematic (velocity, angular velocity etc.) and kinetic (e.g. force output) data the value of performance evaluation increases. As the EMG signal incorporates central control strategies, signal transmission along nerve fibers and across neuromuscular junctions, electrical activation of the muscle fibers organized in elementary motors and through a chain of complex biochemical events, the production of forces acting on the tendons of the agonist and/or antagonist muscles and moving the bones [2].

So, the purpose of the current review manuscript is to share the latest findings on muscular recruitment patterns and their relations to high-level sportive performance.

Materials and methods. The literature on kinesiologic electromyography (EMG) applications, sport biomechanics, high-level sport performance has been reviewed. Besides, the findings from Anadolu University, Movement and Motor Control laboratory combined with the literature. The findings from different sport branches have been chosen as good examples to be used as indicators of the relation between high-level sport performance and muscular recruitment patterns. Archery example has been chosen as the first application of muscular recruitment and its relation to both hits on the target and performance level. Soccer kick to the stationary ball was the second application of contraction/relaxation strategies. Especially, swing leg was analyzed before and after the ball contact.

Results. Muscular recruitment patterns or contraction/relaxation strategies has been reviewed and its relation to performance in a given sport has been discussed. The following subsections include the examples from different sport branches.

1. Archery

Some studies have been conducted to evaluate the muscular recruitment patterns during archery shooting before and after the fall of the clicker. The manuscripts included in their review have used EMG as a main tool in data collection and analysis. Muscles and the joints have been divided into several parts: forearm and pull finger muscles, the arm muscles, the shoulder girdle muscles, and the back muscles.

The recruitment patterns in forearm muscles during the bowstring release critical for accurate and reproducible performance execution in archery. Ertan et al. (2003) [3] conducted a research analyzing the activation patterns in forearm muscles during archery shooting. They included elite (n=10), beginner (n=10) archers, and non-archers (n=10). M. flexor digitorum superficialis (MFDS) and M. extensor digitorum (MED) activations were quantified by using EMG.

Some skill indexes have been created by Ertan et al. (2005) to analyze the correlation between FITA scores and archery skill indexes. They defined negative significant correlation between FITA

scores and log of skill indexes showing that increase in archery experience causes a decrease in area under the processed EMG data. The amplitudes have been found to be lower in highly experienced archers [4]. Besides, Nishizono et al. (1987) have proved that world-class archers have stronger activities of M. deltoideus than that of national level or middle-class archers. Moreover, the muscular contraction level was higher in back muscles than that of the arm muscles in world-class archers compared with middle class and beginner archers. It can be concluded that elite archers use their back and shoulder girdle muscles more than arm and forearm muscles in drawing the string. The advantages of that strategy may be twofold: delayed exhaustion as bigger muscle(s) used [5], and having lower contraction levels of forearm muscles may not cause lateral deflection of the bowstring [6]. The both advantages of the mentioned strategy help increasing the scores on the target.

2. Soccer

Cerrah et al. (2014) worked on a project to define recruitment patterns of knee joint muscles of the swinging leg during the in-step kick. They have related the ball velocity with EMG activity of lower extremity muscles in kicking leg. They included in professional (n=14) and amateur (n=17) soccer players. The rectus femoris (RF), vastus lateralis (VL), vastus medialis (VM), long head of biceps femoris (BF) and medial gastrocnemius (GAS) muscular activities have been recorded and analyzed by using EMG. Three successful maximal in-step kicks using a 0° approach angle with two steps to a stationary ball towards a target have been analyzed. They have found that significantly earlier contraction of BF muscle and reduced activation of RF muscle and an earlier and greater muscle activity occurred in VL and VM in professionals compared to amateur players [7]. The results of their study can be concluded as the higher performance of professional players compared to amateurs appears not to be due to muscle strength, it is thought to be due to the recruitment or contraction/relaxation strategies of agonist and antagonist muscles and co-contraction of synergist muscles during swinging, ball contact and follow-through phases.

Conclusion. The literature suggest that high-level athletes have different muscular recruitment pattern as compared to that of middle-class ones and beginners. Each sport branch has different execution of the given movement pattern that is very important to achieve high performance level. So, each sport branch needs to be evaluated separately and made deep analyses of muscular involvement strategies.

References

1. Ballanger B., Boulinguez P. EMG as a key tool to assess motor lateralization and hand reaction time asymmetries. *J. Neurosci. Methods*, 2009, Vol. 179, No 1, pp. 85-89. DOI: 10.1016/j.jneumeth.2009.01.005

2. Cerrah A.O., Ertan H., Soylu A.R. Evaluating force with electromyography. *Turkish Clinics J. Neurol*., 2010, Vol. 5, No 3, pp. 160-166.
3. Ertan H., Kentel B., Tümer S.T., Korkusuz F. Activation patterns in forearm muscles during archery shooting. *Hum. Mov. Sci*., 2003, Vol. 22, No 1, pp. 37-45. DOI: 10.1016/s0167-9457(02)00176-8
4. Ertan H., Soylu A.R., Korkusuz F. Quantification the relationship between FITA scores and EMG skill indexes in archery. *J. Electromiogr. Kinesiol*., 2005, Vol. 15, No 2, pp. 222-227. DOI: 10.1016/j.jelekin.2004.08.004
5. Acikada C., Ertan H., Tınazcı C. Shooting dynamics in archery. In: Sports medicine and science in archery, 2nd ed. (Eds. E. Ergen and K. Hibner). International Archery Federation, Medical Committee, 2004, pp. 15-36.
6. McKinney W., McKinney M. Archery, 8th ed. Madison, WI: Brown & Benchmark, 1997, 252 p.
7. Cerrah A.O., Gungor E.O., Soylu A.R., Ertan H., Lees A., Bayrak C. Muscular activation patterns during the soccer in-step kick. *Isokinet. Exerc. Sci*., 2011, Vol. 19, pp. 181-190, DOI: 10.3233/IES-2011-0414