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Archery performance level and repeatability of event-related EMG

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Abstract

The purpose of the current study was to compare the repeatability of electromyographic linear envelopes (LE) of archery groups. Surface electromyography (EMG) signals of musculus flexor digitorum superficialis (MFDS) and extensor digitorum (MED) of 23 participants (seven skilled, six beginner archers and ten non-archers) were recorded during archery shooting. Two-second periods (clicker falls at first second) of 12 shots' EMG data were recorded, full-wave rectified and filtered (60 ms moving-average filter) for each participant's drawing arm. Repeatability was investigated by using a statistical criterion, variance ratio (VR). Archers' performances were evaluated in terms of FITA scores. The results showed that FITA scores were significantly correlated to the VRs of MFDS and MED. EMG LEs were more repeatable among archers than non-archers. Therefore, we inferred that VRs of MFDS and MED might be important variables for (a) assessing shooting techniques, (b) evaluation of archers' progress, and (c) selection of talented archers.

PsycINFO classification: 3720

Keywords: Archery; Electromyography; Repeatability; Performance; Variance ratio

1. Introduction

Archery is described as a static sport requiring strength and endurance of the upper body, in particular the shoulder girdle (Ertan, Kentel, Tumer, & Korkusuz, 2003; Mann,

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1994; Mann & Littke, 1989; Martin, Siler, & Hoffman, 1990). High performance shooting in archery is defined as the ability to shoot an arrow at a given target with accuracy (Ertan, Soylu, & Korkusuz, 2005; Leroyer, Hoecke, & Helal, 1993; Martin et al., 1990). In the literature, some of the researchers describe the shot as a three-phase movement: the stance, the arming, and the sighting (Leroyer et al., 1993; Martin et al., 1990; Pekalski, 1990). Alternatively, Nishizono, Shibayama, Izuta, and Saito (1987) divide the shot into six stages: bow hold, drawing, full draw, aiming, release, and follow through. Each of these phases represents a stable sequence of the entire movement. Thus, the task of an arrow shot starts with holding and ends with release or follow-through movements.

During the drawing phase, an archer pushes the bow with extended arm and pulls the bowstring with the other arm. He/she places the bowstring on his/her face (the tip of the nose, the lips, and the chin) for reaching the final position of the drawing phase. In the full draw position, the archer has to perform many tasks simultaneously. He/she should both aim at the target and release the bowstring without disturbing the aiming position and the lateral deflection of the string. Therefore, the release phase must be well balanced and highly reproducible to achieve commendable results in an archery competition (Açıkada, Ertan, & Tınazcı, 2004; Keast & Elliot, 1990; Landers et al., 1992; Landers, Wang, & Courtet, 1985; Leroyer et al., 1993; Martin et al., 1990; Stuart & Atha, 1990).

Releasing the bowstring requires the use of small muscle groups to accomplish the shooting, particularly the coordinated actions of the flexors and extensors of the fingers of the arm responsible for drawing, holding and releasing the bowstring. The archer is supposed to react to an auditory stimulus from the fall of the clicker by coordinating the forearm muscles. He/she contracts the extensor and relaxes the flexor muscles in the forearm to release the bowstring accurately (Ertan et al., 2003). In this way, the archer can produce a pull–push balance between the drawing and the bow arm, and perform a consistent release of the bowstring (Nishizono et al., 1987).

Pulling the bowstring by drawing the arm includes the elbow flexed by concentric contraction of biceps brachii and brachialis muscles, while the shoulder is extended by the strong concentric action of teres major, latissimus dorsi and posterior fibres of deltoid. The pectoral girdle is protected by concentric shortening of trapezius, rhomboid major and rhomboid minor. During the pushing movement of the bow by abduction and flexion of the shoulder, the shoulder is maintained in abduction by isometric contraction of the middle fibres of deltoid, and is then rapidly flexed by the anterior fibres of deltoid and pectoralis major, assisted by coracobrachialis and long head of biceps, all of which work concentrically (Palastanga, Field, & Soames, 2002). When we consider the collective movement of archery shooting, the bow arm is responsible for pushing the bow and adjusting the placement of the sight on the target by resisting the force from the drawing arm (Nishizono, Nakagava, Suda, & Saito, 1984).

If a skilled archer uses a particular strategy for his/her best shooting, i.e., of the kind described in the preceding, can he/she repeat the same strategy? Assuming that surface electromyography (EMG) is a good representative of that strategy, can it be verified with surface EMG? Answers to these questions may provide important results for assessing the shooting techniques, the evaluation of the archers' progress, and objective selection of talented archers.

The purpose of the present study was to compare the repeatability of electromyographic linear envelopes (LE) of archery groups. Surface EMGs of participants were recorded during archery shooting. Previous Federation Internationale de Tirà l'Arc (FITA) scores of