Activation Strategy of Forearm Muscles During Archery Shooting

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Introduction

During archery, the arrow should be drawn back exactly the same position at each trial. A simple device called « clicker », which is a small strip of metal fixed to the bow, is used to eliminate the equipment effect in releasing condition. As the arrow is drawn past the clicker, it snaps against the bow producing a light sound, which is the stimulus for the archer to release the bowstring. In this way there remains only the archer’s own controlled action in response to the stimulus, affecting the performance. There is much speculation about the muscular activation patterns upon clicker sound, specifically on whether the release is affected by relaxation of flexors or by the activation of extensors (Martin, et. al. 1990, McKinney, 1997). The purpose of this study is to analyze the muscular activities in the forearm of bow hand before and after the clicker’ snap by means of EMG synchronized with clicker.

Methods

Three different subject groups were involved in this study. The first group include 5 male and 5 female Turkish National Team archers. For the second group, 5 male and 5 female beginner archers volunteered for this study from Ankara Archery Club. Finally for the third group 10 university student or stuff, 5 male and 5 female, served as the non-archers group.

All the measurements were taken between the dates of July 1 – August 15 2000. Each subject participated in a single test session in the Biomechanics Laboratory of the Mechanical Engineering Department at Middle East Technical University, during which the electromyographic (EMG) activity of flexor digitorum superficialis and extensor digitorum muscles was quantified using surface EMG techniques and the OCTOPUS EMG Cable Telemetry System. Palpating the desired muscles as the subjects simulated the shooting position and performed maximum isometric contraction of these muscles identified recording sites on the drawing arm. The recording sites were prepared first by shaving the region and then lightly abrading and cleansing the area with alcohol (Hennessy, 1990). Skin tack F55 electrodes, filled with conductive electrolyte, were then positioned longitudinally over each muscle (the electrode distance was approximately 2 cm). The reference Electrode was placed on the Olecranon Process of the Ulna of the drawing arm.

Once it was determined that acceptable signals were being recorded, each subject completed three trial shots to have chance to adapt his or herself to the real measurement conditions. Following a brief rest period muscle activity was sampled for a 5-s period as the subjects completed 12 shots. For the shooting trials, the sampling was manually triggered shortly after the archer achieved a full draw position, such that the release of the arrow occurred at approximately the midpoint of the sampling period. In order to synchronize the EMG recordings with the shot, a foot switch was attached under the clicker. Foot switch’s ticks were overlapped with the EMG results in the same frame. The arrow is initially positioned between the unattached end of the clicker and the bow handle. As the arrow is pulled beyond the clicker, the clicker is released against the bow handle, which provides the signal to the archer that the arrow is appropriately positioned for release.

5-sec measurement period decreased to 2 sec as one-second before and after the clicker pulse. Then absolute values of 2-sec measurement were taken to get the rectified EMG results. The data was than averaged at each time station with 100 ms intervals, for successive shots of each subject in order to see the muscular activity of mentioned muscles during this time integrals (Martin et. Al. 1990). Forearm
muscular analysis was made by looking at the results from the integrated EMG. First, muscular analysis was made for each trial of each subject by reaching the integrated EMG figures. Then 12 shots were calculated in the same way. Finally all values of 100 m sec intervals were added to each other and divided into 12 to reach the average integrated score for each subject. All the above procedures were applied to all participant subjects separately.

**Results & Discussion**

The EMG results of Turkish Olympic Archery Team members are shown at Figure 1. The elite archer’s bow release strategy appeared to involve simultaneous relaxation of flexors and contraction of extensors, at around 200 ms after the clicker sound. There was then a modest decrease in integrated EMGs for the third interval following the click signal. Furthermore, a very stable co-contraction pattern of both muscle groups was noted before the clicker signal (Figure 1). The contraction level of both muscle groups

![Figure 1: Averaged and Integrated EMG results of 10 (5 male, 5 female) Turkish Olympic Archery Team members.](image)

changed from subject to subject before and after the click signal. All of the elite archers displayed a higher contraction level in integrated EMG recordings of extensor muscle groups after the click signal. It was not possible to classify the integrated EMGs before the click signal, meaning that each of the subjects displayed his/her own activation strategy before the click signal.

![Figure 2: Averaged and Integrated EMG results of 10 beginner archers (5 male, 5 female) from Ankara Archery Club.](image)
The beginner archers from Ankara Archery Club also employed the same contraction patterns with elite archers after the clicker signal. All of the beginner archers relaxed the flexor group muscles at the same time with an active contraction of extensor group muscles. On the other hand, beginners’ responses to the clicker’s snap occurred at around 300 ms, which was longer than the elite archers’ responses. Beginners also seemed to undergo a preparation phase involving extensor activity before the clicker signal, therefore the contraction pattern of extensor group muscles were higher than the flexor group muscles preciding clicker’s snap (Figure 2).

The non-archers group displayed unstable co-contraction pattern before the clicker. Like the elite and beginner archers, non-archers used extensor contraction strategy after the clicker’s snap. Contrary, there was not clear flexor relaxation at the same time with extensor contraction. Non-archers had a preparation phase, which were caused by the contraction of flexor muscles, before the clicker signal (Figure 3).

![Figure 3: Averaged and Integrated EMG results of 10 non-archers (5 male, 5 female) from Middle East Technical University.](image)

**References**


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