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A PRELIMINARY STUDY ON HOW FATIGUE AFFECTS SCORING AVERAGE IN PROFESSIONAL DARTS

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The purpose of this preliminary study was to identify signs of fatigue in specific muscle groups that in turn directly influence accuracy in professional darts. Electromyography (EMG) sensors were employed to monitor the electrical activity produced by skeletal muscles of the trunk and upper limb during throw. It was noted that the Flexor Pollicis Brevis muscle which controls the critical release action during throw shows signs of fatigue. This was accompanied by an inherent increase in mean integral EMG amplitude for a number of other throw related muscles indicating an attempt to maintain constant applied throwing force. A strong correlation was shown to exist between average score and decrease in mean integrated ECG amplitude for the Flexor Pollicis Brevis.

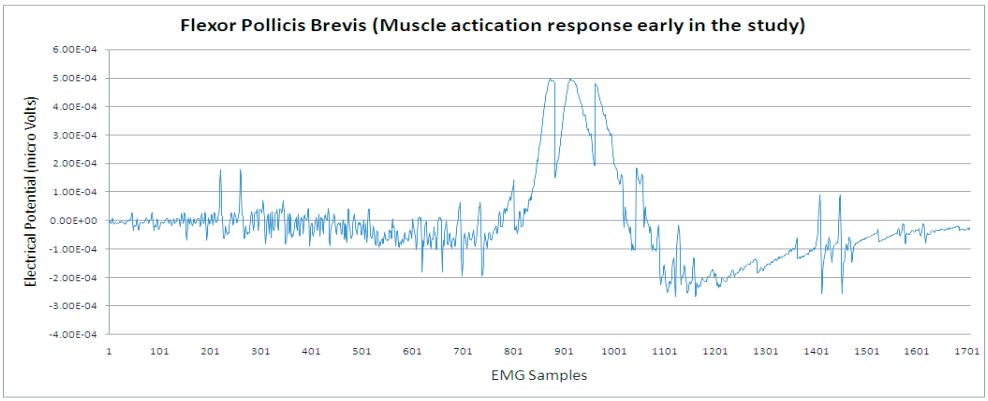
KEY WORDS: electromyography, Flexor Pollicis Brevis.

INTRODUCTION: Correlating performance and the kinematics of the overarm throwing action in darts is difficult for a number of reasons including the movement duration (<200ms) and the large number of variables that will impact the outcome or accuracy of the throw. These factors which include release time, hand trajectory, speed and position at release and centre of gravity can, based on an infinite number of combinations, result in the same outcome. In competitive darts, player technique is therefore optimised by minimising the deviation of as many of these variables as possible (Burke & Yeadon, 2009; Smeets et al., 2002; Walsh, 2011 et al.). This study examined fatigue and its influence on technique and performance for a professional darts player.

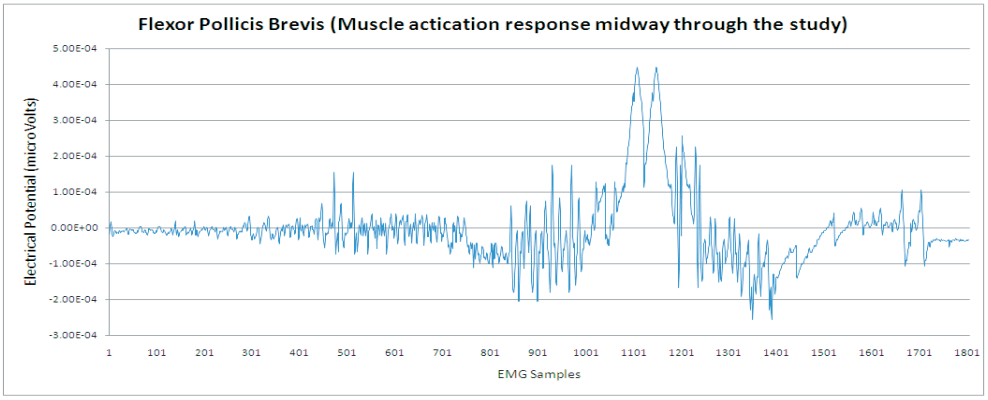
METHODS: Data from a professional player aged 24 years and ranked within the top 75 in the Professional Darts Corporation (PDC) world rankings was used in the analysis for this work. The electrical activity produced by skeletal muscles of the trunk and upper limb during successive throws was evaluated at 4kHz using Zerowire EMG electrodes (Aurion, Italy). Muscle activation patterns were recorded using 8 EMG sensors attached to the player's torso and right upper limb according to SENIAM recommendations, (Hermens, 1999). The electrical potentials generated by Upper and Lower Trapezius, Anterior and Posterior Deltoid, Biceps Brachii, Triceps Brahii, Brachioradialis and Flexor Pollicis Brevis muscle groups were gathered during the trial.
The player performed 150 throws over 40 minutes and attempted in the process to score as highly as possible. Score and the projectile's final position on the target were recorded manually. The player was allowed to select a target area on the dart board in real-time and throughout this the trial the primary target (> 96% attempts) was the triple 20 section of the dart board. The EMG was recorded throughout and analysis of the data was carried out using a number of toolboxes in Matlab. Statistical analysis of the EMG signal in the time domain was conducted using the Statistics toolbox and correlation between average score and EMG was carried out employing the Wavelet toolbox and the Semblance Analysis tool (Cooper & Cowan, 2008).

RESULTS: Figure 1 illustrates the muscle activation pattern for the Flexor Pollicis Brevis after 1, 20 and 40 minutes highlighting the decrease in contraction over time. Figure 2 shows

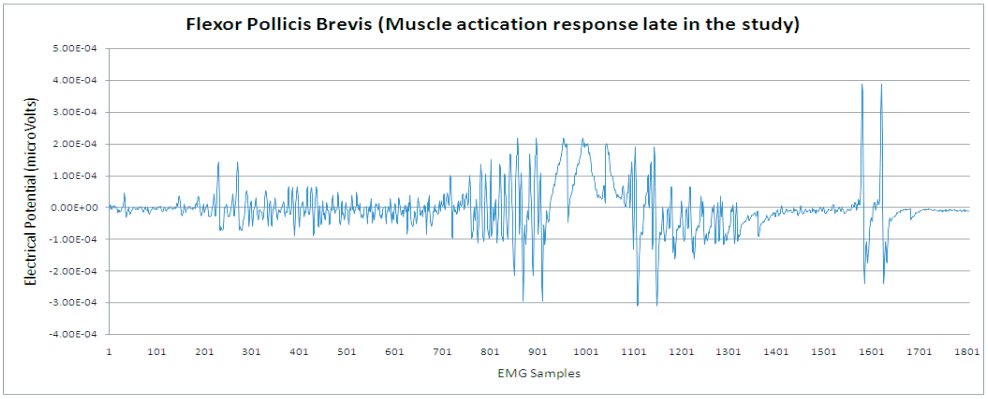
the variation in mean integral EMG amplitude at 1, 20 and 40 minutes for the Upper and Lower Trapezius, Anterior and Posterior Deltoid, Biceps Brachii, Triceps Brahii, Brachioradialis and Flexor Pollicis Brevis muscle groups. In figure 3 the inherent decrease in EMG muscle activation amplitude was shown through semblance analysis to correlate strongly with average score.



(a)



(b)



(c)

Figure 1: Flexor Pollicis Brevis muscle activation pattern (a) after 1 min, (b) after 20 min and (c) after 40 min.

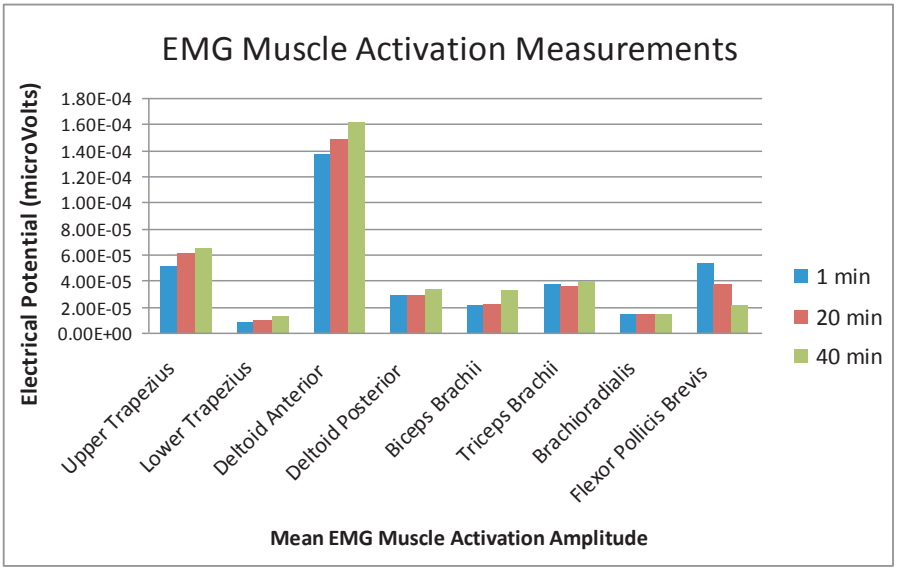


Figure 2: Mean Integral EMG Amplitude for the Upper and Lower Trapezius, Anterior and Posterior Deltoid, Biceps Brachii, Triceps Brahii, Brachioradialis and Flexor Pollicis Brevis muscle groups.

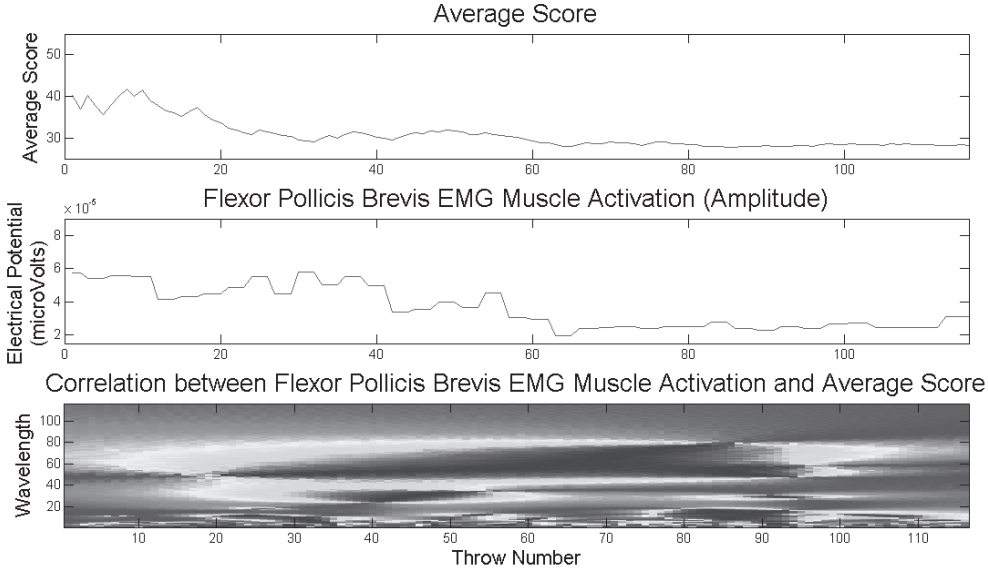


Figure 3: Semblance analysis highlighting the correlation between average score and amplitude EMG muscle activation for the Flexor Pollicis Brevis.

DISCUSSION: The results of this study indicated that for the subject in question there was an inherent decrease in the mean integral EMG amplitude of the Flexor Pollicis Brevis throughout the trial. This muscle is critical to accuracy as it controls release timing which has been strongly correlated with accuracy in darts (Burke & Yeadon, 2009). In addition it has previously been noted that the technically proficient player will seek to keep force applied by the throwing arm constant (Smeets et al., 2002; Walsh, 2011 et al.). In this trial other throw related muscles increase in mean integral EMG amplitude indicating an attempt to maintain constant applied throwing force as would be expected from a technically accomplished player. A strong correlation was also shown to exist between average score and decrease in mean integral ECG amplitude for the Flexor Pollicis Brevis. This would seem to agree with previous works highlighting the importance of release timing (Smeets et al., 2002).

CONCLUSION: This study highlighted that the Flexor Pollicis Brevis muscle which controls the critical release action during throw shows signs of fatigue over prolonged periods of throwing. This was accompanied by an inherent increase in mean integral EMG amplitude for a number of other throw related muscles indicating an attempt to maintain constant applied throwing force. A strong correlation was shown to exist between average score and decrease in mean integral ECG amplitude for the Flexor Pollicis Brevis. Future work will perform additional trials comparing amateur and professional players and will be accompanied by EMG data analysis in the frequency domain to validate findings to date.

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