Muscle Fatigue Differences in Flexor Digitorum Superficialis Muscle of NCAA Division III Athletes and Nonathletes

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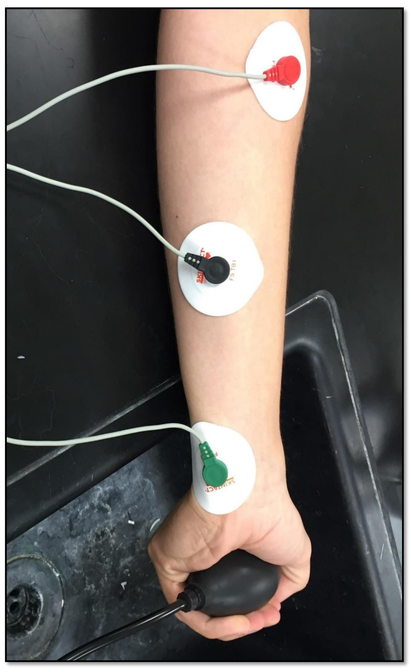
Abstract

The flexor digitorum superficialis (FDS) muscle is located in the anterior portion of the forearm. It flexes the proximal interphalangeal joints of digits 2 through 5, and aids in flexion of metacarpophalangeal joints. It has been shown that differences in fatigability exist in the FDS muscle of division I athletes versus nonathletes (1,2); however, whether these differences extend to division III athletes versus nonathletes is unknown. **PURPOSE**: The aim of this study is to examine differences in both the onset and rate of fatigability in the FDS muscle of both athletes and nonathletes at the division III level. It is hypothesized that fatigability differences between athletes and nonathletes which exist at the division I level also manifest themselves at the division III level with respect to fatigue. **METHODS**: Division III athletes (n = 20) and nonathletes (n= 25) between 18 and 22 years of age were recruited from the population of undergraduates enrolled full-time at Lakeland University. Because of the position and action of the FDS muscle, it was used to measure fatigability during isometric contraction via electromyography (EMG) in a grip strength paradigm. Participants compressed a handheld dynamometer while total force and FDS electrical activity was measured. Once peak force was attained, the experimental session proceeded until EMG activity fell below 50% of peak force; sessions typically lasted approximately one minute, but varied by individual as to when they reached 50% of peak force. Sessions were conducted in both the dominant and nondominant arms of the participants. Time was binned into fourteen 5-second intervals, and EMG activity was compared via one-way ANOVA and post hoc testing within these intervals. Time to ½ maximal force development was also measured. **RESULTS**: A significant difference was observed in the time it took to reach ½ maximal force between athletes dominant arm and nonathletes, nondominant arm (31.33 ± 11.77 seconds versus 21.25 ± 9.88 seconds, $p < 0.05$). During binned time intervals, FDS activity was not statistically significant between groups. It was expected that there would be a difference in fatigability between athletes and nonathletes in both dominant and nondominant arms, given the differences that exist in muscle physiology between division I athletes and nonathletes (3,4). However, these data suggest that this difference does not extend to muscle fatigue in division III athletes. Because this other studies have established physiological differences in division I athletes and nonathletes, future efforts must be focused on establishing the validity of assessing FDS muscle fatigue in this grip strength paradigm, potentially by partnering with a nearby division I school.

Experimental Design and Methods

- Participants in the study consisted of healthy students currently enrolled at Lakeland University. Those who participated in a division III sport within the last year (with the exception of golf) were considered athletes; all other participants were considered non- athletes.
- Participants were asked to abstain from caffeine for 12 hours before the study.
- To locate the flexor digitorum superficialis (FDS) muscle, the fourth finger (ring figure) was flexed against a fixed, external surface causing the FDS muscle to become visible. Both arms were then abraded with an antiseptic wipe, and electrodes were placed across the FDS muscle.
- The participant was then seated with their arm extended on a flat surface, while holding a dynamometer with their wrist extended at a 40º angle. This position prevented FDS wrist flexion.
- The participants were shown an example of how to achieve this position and how to correctly squeeze the dynamometer continuously.
- Participants were asked to exert maximal force initially in a continuous squeeze, using their dominant arm first. The same protocol was then followed for participants' non- dominant arm. Total force and FDS muscle activity were recorded.
- The recording was ceased when participants' FDS muscle reached 50% of initial force generated.



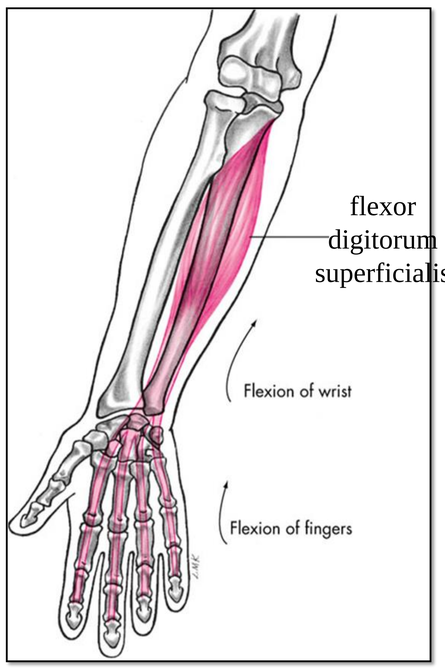


Figure 1: A: The position of electrodes during EMG recording. The black (negative) lead was placed over the belly of the FDS muscle, while the red (positive) lead was placed over the base of the muscle. The green electrode is the ground. During recording, the wrist was bent to 40° and the dynamometer was squeezed. B, A schematic image of the FDS muscle. FDS Originates at the medial epicondyle of the humerus, ulnar collateral ligament, and the coronoid process of the ulna. The point of insertion is the middle phalanges of digits 2- 5. The muscle flexes the middle phalanges of the proximal interphalangeal joints of the medial four, and assists in flexing the proximal phalanges at metacarpophalangeal joints of the hand.

Results

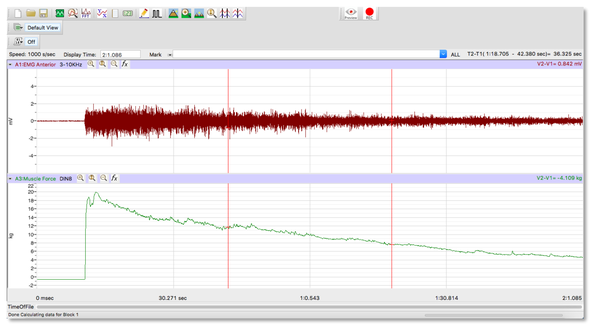


Figure 2: A representative trace of FDS EMG activity (top) and total force produced (bottom). FDS activity was calculated as the integrated value of muscle activity in 5 second intervals Total force was calculated by determining the area under the curve in 5 second intervals. Peak force occurs initially, when the participant squeezes the dynamometer. Isometric contraction is continued until the participant reaches 50% of this peak value.

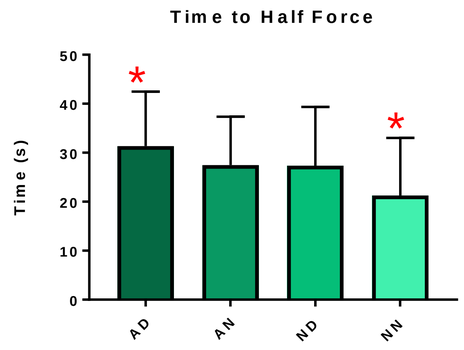


Figure 3: Latency to reach 50% of peak force during isometric contraction. AD, Athlete dominant arm; AN, Athlete nondominant arm; ND, Nonathlete nondominant arm; NN Nonathlete nondominant arm. The only statistically significant difference occurred between the athlete dominant group and the nonathlete nondominant group.
* $p < 0.05$, One- Way ANOVA followed by Tukey test

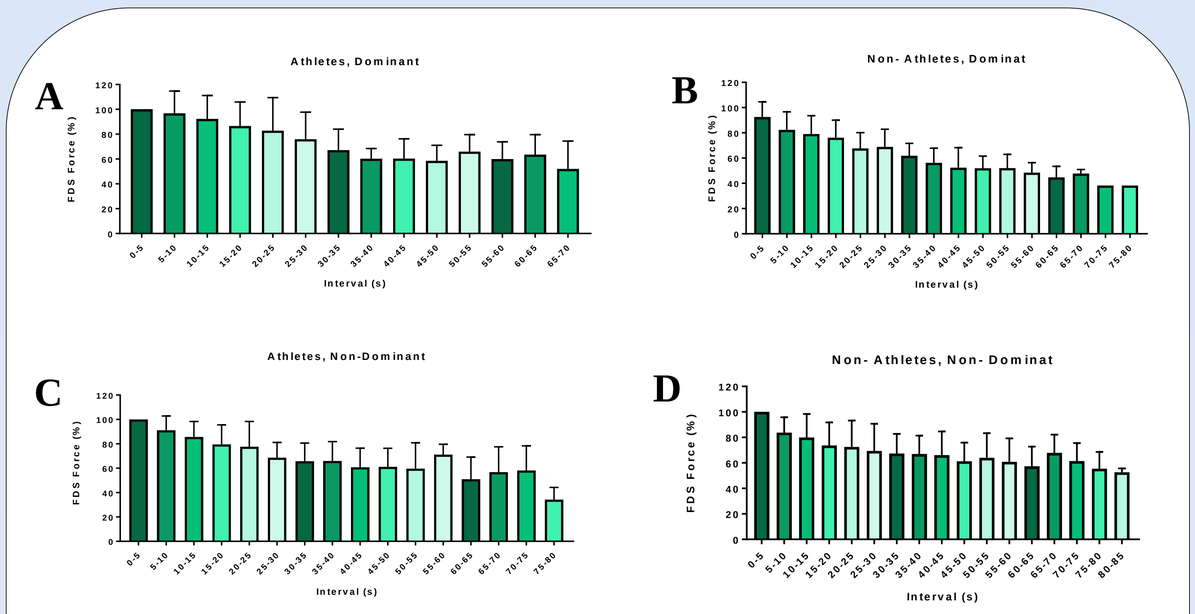


Figure 4: Decrease in FDS muscle force generation over time. Experiments were broken into 5 second intervals (bins) and data were were normalized to the amount of force generated between 0-5 seconds. No statistical difference was observed between any of the groups at any time point.

Conclusions and Future Work

- These data suggests no significant differences between athletes and non- athletes dominant and non-dominant FDS muscles total force in Division III schools. Expanding the number of participants could help reveal significant differences.
- One explanation for lack of significance is that the protocol used is insufficient to measure differences in fatigue. It is necessary to partner with a division I school, where differences in muscle physiology have been shown to exist, to determine if our measures are able to recapitulate previously published work.
- Another explanation is that pooling all athletes together concealed areas in which there was a significant difference. Examining athletes in groups (by gender, sport, season, etc.) may help elucidate differences that exist within these groups, but are not seen when data is pooled.
- A third explanation is that these data illustrate the lack of physiological differences in muscle fatigue at the division III level between athletes and nonathletes.

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