ISOMETRIC AND DYNAMIC ACTIVATION CHARACTERISTICS OF THE HUMAN LATISSIMUS DORSI MUSCLE

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INTRODUCTION

The latissimus dorsi (LD) muscle has a unique design with an origin spanning the thoracic and lumbar spine and a common insertion point on the anterior humerus. Due to the LD muscle having a large surface area, broad spine attachment, obliquities in fiber direction and variability in neurovascular supply, previous researchers have suggested possible compartmentalization of its primary functions [1]. Furthermore, from an anatomical standpoint, functional differences between the thoracic and lumbar portion of the LD have been identified in cadaveric specimens; these differences include variation in physiological cross-sectional area and fascicle length [2]. The purpose of the current study was to identify the isometric and dynamic activation characteristics of the LD muscle. Based on previous works it was expected that the thoracic and lumbar components of the muscle would show different temporal and spatial electrical activation characteristics during both isometric and dynamic tasks.

METHODS

Eight male (mean age 23 ± 1.8 years; height 1.8 ± 0.04 m; and mass 76.9 ± 10.6 kg) and eight female (mean age 22 ± 1.2 years; height 1.7 ± 0.09 m; and mass 61.6 ± 8.6 kg), recreationally active, right hand dominant individuals participated in this study. The LD muscle was characterized about four separate compartments with reference to their spinal origin (two thoracic and two lumbar compartments, see Fig. 1). Surface EMG (sEMG) was obtained from each of these T10, T12, L1 and L4 compartments.

LD activation was obtained during both maximal isometric, as well as submaximal dynamic tasks. Isometric activation tasks included a) humeral adduction (ADD), b) humeral adduction and internal rotation (ADD + INT), c) chest-supported row (ROW) and d) humeral extension (EXT) maximal voluntary isometric contractions (MVICs). Dynamic activation tasks included sagittal lifting/lowering movements spanning the a) floor to knee (FK), b) knee to hip (KH) or c) hip to shoulder (HS). Male and female participants lifted an absolute load of 12 kg and 8 kg, respectively.

sEMG data were linear enveloped by rectifying and low-pass filtering (2nd order Butterworth, 2.5 Hz cut-off). MVIC techniques were compared to determine which technique elicited the true participant MVIC (tMVIC). All other isometric and dynamic sEMG were normalized to tMVIC. LD compartments were compared during both isometric and dynamic activations for differences in normalized, linear-enveloped sEMG magnitude, and relative activation timing (cross-correlation; $r_{xy}$). Differences in sEMG magnitudes for isometric and dynamic activations were assessed using separate two, and three way ANOVAs respectively ($\alpha = 0.05$). Post hoc pairwise comparisons were made using a Tukey adjustment within each ANOVA.

Figure 1: LD muscle compartments showing T10, T12, L1 and L4 sEMG electrode sites from superior to inferior.
RESULTS AND DISCUSSION

For the MVIC tasks there was no significant difference in sEMG signal magnitude between LD compartments (p = 0.6116). Significant differences between MVICs (p < 0.0001) showed that the ROW and EXT techniques elicited larger activations than the ADD or ADD + INT techniques (p < 0.0001). Relative sEMG activation magnitudes for each MVIC (across all LD compartments) can be seen in Fig 2A. No temporal activation differences were observed for any LD compartment throughout any of the MVIC tasks (rxy = 0.9607).

Peak dynamic sEMG magnitudes were observed to differ significantly with main effects of dynamic lift type (FK, KH, HS) (p = 0.0470) and LD compartment (p = 0.0002). Specifically, larger peak sEMG activation was seen in the T10 (p = 0.0002) and L4 (p = 0.0076) compartments relative to the T12 compartment. Mean dynamic sEMG magnitudes were observed to differ significantly with main effects of lifting versus lowering (p < 0.0001) and LD compartment (p = 0.0002). Larger mean sEMG activation was seen in the T10 (p = 0.0001) and L4 (p = 0.0146) compartments relative to the T12 compartment. Relative peak and mean sEMG activation magnitudes for each LD compartment (across all lifting types) can be seen in Fig 2B. No temporal activation differences were observed for any LD compartment throughout any of the dynamic tasks (rxy = 0.9114).

CONCLUSIONS

For MVIC-style activations of the LD muscle, compartmentalization of function is not apparent. For all MVIC types LD compartment activation was uniform in sEMG magnitude and timing. During dynamic activations differences in activation magnitude may suggest some compartmentalization of the LD; however activation timing was always uniform. Additionally, from this work it was determined that the optimal sEMG normalization-electrode site combination was the ROW task at T12. Similar LD EMG normalization suggestions have been made previously [3].

REFERENCES