The Relationship Between Muscle Activation and Handwriting Quality with Different Grip Styles

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Abstract

Purpose: This study identified the differences in muscle activity, handwriting legibility, and consistency when using the four primary handwriting grip styles: dynamic tripod (DT), dynamic quadrupod (DQ), lateral quadrupod (LQ) and lateral tripod (LT). It was hypothesized that different writing styles would alter muscle recruitment, writing legibility, and consistency. Methods: Thirty-four 18-22-year-old subjects underwent three protocols consisting of a handwriting legibility test and a consistency and handwriting metrics protocol. The legibility test was conducted on paper. The consistency and metrics protocols included surface electromyography (EMG) to measure the activity of 8 muscles associated with handwriting and were performed on a digital tablet. The tablet measured stroke duration, length, velocity, and pen pressure. Subjects used each grip style with all protocols and scores were normalized to their native grip. Grip styles were compared using a RM ANOVA, t-tests, and correlations to evaluate relationships. Significance was set at p<0.05 and a trend at p<0.10.

Results:

- Each score was normalized to each subject’s native grip style and presented as a percentage of the native grip style’s score.
- Greater UT activity was significantly correlated with lower consistency scores for both the DT (r=−.709, p<.000) and DQ grip styles (r=−.509, p<.000).
- Greater UT activity significantly correlated with higher consistency scores for the LT grip style (r=.513, p<.002).
- Greater PPB activity correlated with a lower consistency score (r=−.300, p=0.08) in the LT grip style.
- Females produced less variability in legibility scores and performed better than males in the DT grip style.
- For each grip style, the alphabet (uppercase and lowercase) and the sentence “John saw the red truck coming” were written on a digital tablet. 

Discussion:

- The UT has been shown to be a stabilizing muscle for handwriting3. Per our results, lateral grip styles require greater whole-arm stabilization than dynamic.
- Dynamic grip styles, especially DT, required more extrinsic hand muscle use, such as the ECU. Suggested by Elliott and Connolly, this extrinsic muscle use is needed to produce fine distortive movements5.
- In lateral grips, more UT recruitment was related to an increase in consistency.
- Although no grip style is more advantageous to handwriting legibility and consistency, it is important to note that lateral grips must recruit more of the UT in order to produce similar handwriting consistency to that of dynamic grips.
- LT was anecdotally an uncomfortable grip style and resulted in longer stroke durations.

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