Muscle Activity during Handwriting: An EMG-Study with Adults

Stephanie White1,2, Stephan Kopinski2, Gerit Brenner2, Frank Mayer1 and Julia Festman2
1Department of Sports Medicine and Sports Orthopedics, University of Potsdam Research Group, Diversity & Inclusion, University of Potsdam
2Excellence Clusters Transregio 51

Background
- Writing is an essential skill in life and also associated with academic success [1].
- As motor skills are considered to be a relevant factor in handwriting development, the functional relationship of the hand, arm and shoulder girdle muscles has been investigated in handwriting research [2-4].
- Muscle activity (MA) of the hand, arm, and shoulder girdle is known to differ in its contribution to handwriting movements [2,4], yet differences of MA in proficient writers are not fully understood.
- Investigating MA in proficient handwriters may help specify further the functional relationship of the hand, arm and shoulder girdle in handwriting process and may present a reference for MA in handwriting development.

The purpose of this study was to investigate the functional relationship of the hand, arm, and shoulder girdle in terms of muscle activity in adults during handwriting.

RQ1: Does muscle activity differ between writing tasks?
RQ2: Does muscle activity differ between muscles?
RQ3: What is the relationship between segments of the arm?

Methods

Participants & Design
- 21 healthy adults (11, 28 ± 2 yrs / m 10, 27 ± 1 yrs) in cross-sectional study design

Materials & Devices
- EMG: wireless surface electromyography (sEMG) system (Myon RFTD, Myon AG, CH), receiver and pairs of bipolar Ag/AgCl transmitting surface electrodes
- Microsoft Surface 3 tablets with Microsoft Windows 8 operating system and stylus

Outcome Parameters
- Writing: number of inversions in velocity (NIV) = sum of changes of acceleration and deceleration
- EMG: amplitude [RMS] normalized to maximum voluntary contractions (%MVC)

Procedure
- sEMG setup: thumb (TH), wrist flexors (FL) and extensors (EX), and upper trapezius (TR)

Figure 1: Surface electrodes are attached to (a) TH muscle group, (b) EX & FL muscle group, & (c) TR muscle group

Normalization task: MVC 5 times each muscle group (10 sec breaks in between)

Figure 2 a-d: task examples: (a) triangle, (b) „C“, and (c) „gelb“, (d) Tablet display with stylus

Writing Tasks: 3 tasks (7 items, each in 1 stroke; each item 5 times)

Figure 3: Triggered absolute EMG data [V]: example of the letter “C” for four muscle groups: thumb (TH), wrist flexors (FL) and extensors (EX), and upper trapezius (TR)

Figure 4: Normalized EMG data of all tasks (N = 21). Mean ± SD of normalized data during SHP, LET and WOR tasks for the TH, FL, EX and TR muscle groups. Asterisks mark significant differences at the 0.05 level.

Conclusion
- RQ1: Depending on the handwriting task, normalized muscle activity differs in the hand, arm, and shoulder girdle.
- RQ2: The normalized muscle activity differs between hand, wrist, and shoulder girdle muscles in proficient hand writers.
- RQ3: The thumb and wrist show a positive functional relationship in muscle activity during handwriting tasks. The thumb and shoulder show an inverse relationship in muscle activity during handwriting tasks.

References