TYPING STYLE AFFECTS ARM KINETICS, KINEMATICS AND MUSCLE ACTIVATION

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INTRODUCTION

Many different typing styles exist in the workplace. The common typing styles are "two-finger" typing and touch-typing. Two-fingered typists use a maximum of two fingers per hand and often look at the keyboard. Touch-typists use all fingers of both hands and infrequently look at the keyboard. Ergonomic interventions lean towards "relaxed" touch typing methods [1,2]; however, typing styles have not been quantified through biomechanical measures. This study aims to determine the effects of two different typing styles on posture, joint torque, and muscle activity in the upper extremity. These findings inform prevention efforts with reduced biomechanical loading, thus possibly reducing the risk of developing musculoskeletal disorders (MSDs).

METHODS

Two groups of participants were recruited according to their typing style: 15 two-fingered typists (11 men, 4 women, mean age 44 years old) and 16 touch-typists (7 men, 9 women, mean age 39 years old). Participants completed a typing task consisting of transcribing text into a word processing document. Two minutes of force and kinematic data were collected after some practice time.

Three-dimensional (3-D) kinematics of the right upper extremity were recorded using an active-marker infrared motion analysis system (Optotrak Certus System, Northern Digital, Ontario, CAN). Typing force was measured by a 6-axis force-torque transducer (ATI Industrial Automation, model Gamma, SI-65-5.5, Apex, NC, USA) underneath the right-hand side of a split keyboard, and electromyographic (EMG) activity from eight muscles of the arm was recorded during the task (DE-2.1 Single Differential Electrode; Delsys, Boston, MA, USA).

All joint angles were calculated with respect to a neutral posture in which the elbow was flexed 90^o and the forearm was pronated 180^o relative to the anatomical position. A 3-D multi-segment inverse dynamic model [3,4] calculated net torques for the right wrist, elbow and shoulder joints. Root mean square (RMS) EMG signals were normalized to maximum voluntary contractions.

Summary statistics were calculated for the upper extremity 3-D postural and joint torque data. Angle and torque variation was calculated as the standard deviations averaged across participants. Distance from the keyboard was calculated as the horizontal distance between the right acromion and the front of the keyboard. These biomechanical parameters were averaged across the whole trial (2 minutes). For the muscle activity data, the 10th, 50th and 90th percentiles provided metrics in the distribution-EMG signal amplitude.

Sample t-tests were used to determine the effect of typing style on the biomechanical parameters (alpha = 0.05).

RESULTS AND DISCUSSION

Touch typists had significantly higher shoulder internal rotation angle and wrist ulnar deviation (Table 1), which might be explained by the fact that they sat significantly closer to the keyboard compared to two-fingered typists (32.8 (1.3)cm vs. 28.2 (0.9)cm respectively). Two-fingered typists had significantly higher variation for shoulder rotation and flexion angles (Table 1).

Two-fingered typists had generally higher total joint torques and total torque variation compared to

touch-typists, with wrist total torque and torque variation being significantly different between the two groups (Table 1). More specifically, the two-fingered typists had significantly higher wrist RMS torque in flexion/extension (0.28 (0.02)Nm vs. 0.19 (0.02)Nm respectively) and in rotation (0.29 (0.04)Nm vs. 0.20 (0.02)Nm respectively), and significantly higher shoulder torque variation in flexion/extension (0.46 (0.05)Nm vs. 0.32 (0.04)Nm respectively), rotation (0.29 (0.04)Nm vs. 0.20 (0.02)Nm respectively), as well as in add/abduction (0.21 (0.02)Nm vs. 0.14 (0.01)Nm respectively). All other RMS torques and torque variations were not significantly different between the two groups. These results suggest that joint loads are different between the two typing styles in terms of frequency and magnitude.

The 10^{th} percentile value of EMG amplitude for the anterior deltoid muscle was significantly greater for two-finger typists ($p = 0.047$), which means that static shoulder muscle loading was higher for two-finger typists compared to touch-typists.

CONCLUSIONS

Two-finger typists had larger dynamic loading and increased variability in joint torques and postures compared to touch typists. These differences suggest that injury mechanisms for the upper extremity associated with computer work may be different for the two typing styles.

REFERENCES

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Table 1: Across subject mean (s.e.) joint angles and angle variation (s.e.) for two-fingered typists (Finger) and touch-typists (Touch).

	Flexion				Internal rotation				Abduction			
	Finger		Touch		Finger		Touch		Finger		Touch	
Shoulder												
mean angle (deg)	-2.84	(1.66)	-2.20	(1.09)	**19.43**	**(1.37)**	**26.14**	**(1.84)**	-7.21	(0.89)	-6.88	(1.21)
angle variation (deg)	**2.51**	**(0.32)**	**1.52**	**(0.24)**	**4.21**	**(0.47)**	**1.80**	**(0.17)**	1.14	(0.16)	0.83	(0.09)
Elbow												
mean angle (deg)	-7.53	(1.20)	-4.94	(1.49)	8.61	(1.91)	4.11	(2.18)	-	-	-	-
angle variation (deg)	1.97	(0.42)	1.44	(0.12)	2.85	(0.26)	2.75	(0.21)	-	-	-	-
Wrist												
mean angle (deg)	-25.20	(2.11)	-20.04	(2.28)	-	-	-	-	**13.83**	**(1.29)**	**19.13**	**(1.47)**
angle variation (deg)	6.25	(0.36)	5.54	(0.34)	-	-	-	-	3.25	(0.26)	3.16	(0.31)

*Negative angles mean that the angle is in the opposite direction from that stated in the column heading (ex: negative shoulder flexion is extension). Statistically significant differences between the two groups are in bold.

Table 2: Across subject mean (s.e.) total joint torques and total torque variation (s.e.) for two-fingered typists (finger) and touch-typists (touch). Statistically significant differences between the two groups are in bold.

	Finger		Touch	
Shoulder				
mean total torque (Nm)	2.05	(0.69)	1.20	(0.40)
total torque variation (Nm)	1.42	(0.54)	0.60	(0.17)
Elbow				
mean total torque (Nm)	0.35	(0.11)	0.19	(0.07)
total torque variation (Nm)	0.22	(0.05)	0.11	(0.03)
Wrist				
mean total torque (Nm)	**0.01**	**(0.00)**	**0.00**	**(0.00)**
total torque variation (Nm)	0.00	(0.00)	0.00	(0.00)

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