EFFECT OF KEYBOARD KEYSWITCH DESIGN ON FINGER MUSCLE ACTIVITY DURING TAPPING ON ISOLATED KEYSWITCHES

Lee, D. L., Dept. of Environmental Health, Harvard School of Public Health, Boston, MA, USA;
Kuo, P., Dept. of Mechanical Engineering, Harvard Univ, Sch. of Engineering; Cambridge, MA, USA;
Jindrich, D. L., Dept. of Kinesiology, Arizona State University, Tempe, AZ, USA;
Dennerlein, J. T., Dept. of Environmental Health, Harvard School of Public Health, Boston, MA, USA.

Aims: Intensive computer keyboard use is associated with hand and forearm musculoskeletal pain [1]. The design of the keyswitch may play a fundamental role since the fingertip ultimately interfaces with the input device through the keyswitch. Previous studies have shown that finger kinematics and dynamics vary across keyswitch designs during tapping [2], however, these studies did not examine the specific relationship between keyswitch designs and intrinsic/extrinsic finger muscle activity. Therefore, this study aims to measure and characterize the index finger muscle activity patterns while tapping across isolated keyswitches of varying force-displacement characteristics.

Methods: In a repeated-measures laboratory experiment, six subjects (3 females, 3 males) tapped with their right index fingers on three isolated keyswitches (1 buckling-spring, 2 rubber-dome) of varying force-displacement characteristics (Table 1) extracted from PC and Apple keyboards. Intramuscular (finewire) electromyography (EMG) provided a measure of muscle activity for the intrinsic muscles of the first lumbrical (LUM) and first dorsal interossei (FDI), and extrinsic muscles of the flexor digitorum profundus (FDP), flexor digitorum superficialis (FDS), and extensor digitorum communis (EDC) [3].

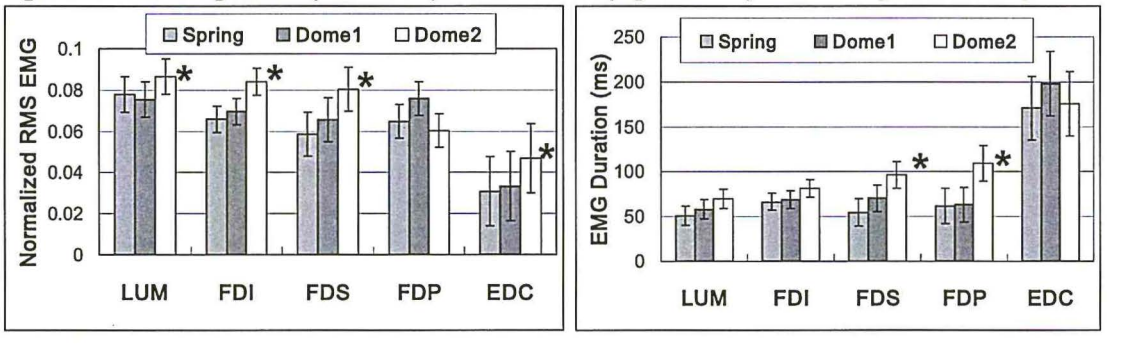
Table 1. Keyswitch characteristics.

Keyswitch	Activation Force	Key Travel
Spring	0.6 N	3.5 mm
Dome 1	0.6 N	3.8 mm
Dome 2	1.0 N	2.5 mm

Muscle activity was characterized in terms of both magnitude (RMS EMG normalized to the highest EMG signal) and duration (time between onset and offset of muscle activity relative to initial keyswitch contact). Differences in EMG magnitude and duration across keyswitch design were analyzed using mixed effects analysis of variation models (Proc Mixed in SAS).

Results: EMG magnitude and duration for both intrinsic and extrinsic muscles varied across keyswitch design (Figure 1; $p<0.01$). The keyswitch with the highest switch activation force and smallest key travel (Dome 2) was significantly associated with higher EMG magnitude for both intrinsic and extrinsic muscles, and only extrinsic muscles for EMG duration ($p<0.01$). Between the designs of similar keyswitch characteristics (i.e., Spring and Dome 1), the differences in both intrinsic and extrinsic muscle activity patterns were not statistically significant.

Figure 1. EMG magnitude (left insert) and duration (right insert) across keyswitches. *p<0.01



Conclusions: Our findings indicate that tapping on keyswitch designs with lower activation forces, regardless of the switch mechanism (i.e., buckling-spring vs. rubber dome) reduces finger muscle activity patterns. Implications for these findings include the design of future keyswitches to reduce the exposure to risk factors that contribute to development of upper extremity musculoskeletal pain associated with intensive keyboard use.

References

1. Lassen et al., 2004. American Journal of Industrial Medicine, 46, 521-553.
2. Jindrich et al. 2004. Clinical Biomechanics, 19, 600-608.
3. Kuo et al, 2006. Journal of Biomechanics, 39, 2934-2942.

PREMUS 2007

Sixth International Scientific Conference on Prevention of Work-Related Musculoskeletal Disorders

27–30 August, 2007
The Conference Center at Harvard Medical
Boston, Massachusetts, USA

Book of Abstracts