Effect of keyboard design on forearm muscle activity and posture

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Introduction:
Among the various input devices, keyboard is the most common device, and the type of keyboard was the only factor that significantly affects the posture and muscles activity. Use of standard keyboard was associated with constrained hand and mechanical stress, which are the primary causes of upper extremity musculoskeletal disorders. Though, new geometries of keyboards have come in the market and have been recognized to provide comfort and safety, the conventional keyboards are far more common in use due to its cost concern, availability, acquaintance, training and other reasons. Previous literature reviewed on the effect of different types of keyboards including, standard and alternative keyboards revealed that muscular load and postural analysis are very distinct feature from the point of view of human-computer interaction. However, it appears from the literature that not many studies have been conducted in the past exclusively on the varieties of conventional keyboards, available from different manufacturing background. Keeping these facts in view present study was designed to investigate whether different types of standard keyboards had significant impact on operator’s muscular activity and upper extremity posture.

Method:
Eight healthy, young, sedentary males (computer professionals) (age, 21 ± 1.1 years; body height, 168.9 ± 12.1 cm; body weight, 56.4 ± 8.2 kg) volunteered in the study. An experimental set up included an adjustable chair-desk in which monitor and standard keyboard and mouse were placed. The impact of different keyboard design (KB1, KB2, KB3 and KB4) was studied by four different trials under taken independently during text entry task. Each experimental trial consisted of three data acquisition periods of 1 min each with about 2 min interspacing, during which muscle activity and upper extremity joint angles were recorded and digitized. The volunteers were given about 10 min rest break in between the keyboard test conditions. A 3-D motion analysis of infra red 4camera system recorded movements of bilateral elbow and wrist joints and the electromyographic activity of the back
and forearm muscles were recorded bilaterally via an eight-channel EMG System. Quantification of the myoelectrical signal was done to compare the relative involvement of the muscles, in terms of the RMS amplitude values of bilateral forearm muscles and back muscles. The reference task was used for normalization of signal, i.e., the RMS amplitude values of the myoelectric signals of test conditions were expressed as the ratio of the activity value at reference relaxed seated posture. The statistical treatment of the EMG data and joint angle measurements were done by the help of SPSS software (version 6.0). The descriptive statistics, the frequency and percentile point distribution of the upper extremity (elbow and wrist) angles were computed. The one-way analysis of variance (ANOVA) and post-hoc tests were applied to examine whether different keyboard design had any significant influence on the muscles activities and upper extremity postures.

Results:
The result of the present study indicated that the effort of bilateral forearm and back muscles and the upper extremity postures varied with the use of different keyboard. Moreover, it was found that bilateral forearm and back muscles load are significantly less with the use of curved keyboard (i.e., KB 4) and forearm and upper shoulder muscles load increased with increase in slope. The result of the present study indicated that the effort of bilateral forearm and back muscles and the upper extremity postures varied with the use of different keyboards. The right and left elbow extension was almost similar for both KB 3 and KB 4. The mean elbow extension increased slightly with the use of KB 1. Predominantly the bilateral wrist extension was within the range 20 to 25° for both KB 2 and 4, whereas, it increased to 30 to 35° with KB 3 and 25 to 30° with KB 1.

Discussion:
The findings of the present study favoured that the use of ultra-thin, flat, ergo-shaped keyboard (i.e., KB 4) might be useful to the professional computer users in maintaining the elbow in anatomical position nearly at 90° or greater and to reduce the forearm and back muscle activities, whereas, the shoulder muscle, i.e., upper trapezius activity increased with increase of keyboard inclination and found least with flat keyboard (0°).

Keywords: Computer standard keyboard; design; muscle activity; 3D motion analysis.