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CLINICAL CARE UPDATE

OUTCOMES OF MOUSE-KEYBOARD TRAINING

This is the second part of a two-part article on a three-phase outcome study of a mouse and keyboard training technique.

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As mentioned in the first part of this article, the MouseKeyDo™ System is a training program designed to treat and prevent computer-related repetitive strain injury.

Researchers conducted a three-phase investigation into the efficacy of the training system and found that patients had less pain and the same or improved function during mouse and keyboard work after undergoing the training program. This article features findings from Phase III of the study. (Refer to the Feb. 9, 2004 edition for information on Phases I and II of the study.)

Phase III: Surface EMG and Joint Range of Motion.

Methods:

Surface electromyography (surface EMG) is a non-invasive method of measuring the electrical activity of muscles by placing a recording electrode on the skin surface over the muscle groups to be studied.

The study involved a repeated measures design where surface EMG changes and joint range of motion changes during a two-minute keyboard and mousing task were measured simultaneously for each subject before and after MouseKeyDo™ training.

The scientific literature has documented the relationship between muscle force production and surface EMG amplitude. Comparisons show the quantitative changes which occur in each subject before and after undergoing training for each variable studied. Chair, monitor, keyboard, and mouse were adjusted in accordance with current ergonomic standards.

Intervention:

Training consisted of 12 hours of group training (six two-hour sessions over a six-week period). Sessions included:

- Evaluation by a physician.
- Sitting posture and flexibility program.
- Ergonomic evaluation.
- Training in mouse and keyboard technique.

Measured Variables:

1) **Surface EMG during keyboard and mouse work** (refer to Page 3, Figure 1): Simultaneous recordings of surface EMG root mean square (RMS) activity in the right upper limb and neck were taken by placing electrodes over the motor point (midpoint of the muscle) of seven muscles. (Delagi, 2nd Edition, 1981.) The tension in all seven muscle groups was recorded simultaneously during two minutes of typing and mousing before and after training. For the described action of each muscle, it is assumed that the subject is in a sitting position with the hands and fingers positioned on the keyboard or mouse with palms face down.

   Muscle groups in the study include:

- Upper trapezius.
- Biceps.
- Triceps.
- Flexor digitorum profundus (forearm muscle palm side, which lowers wrist and fingers to depress the keys or the mouse button).
- Extensor carpi radialis brevis (extensor muscle back of arm, which raises the hand and fingers off the keys or mouse).
- Flexor carpi ulnaris (wrist muscles controlling the twisting of the wrist to the fifth finger or pinkie side).
- Abductor pollicis longus (wrist muscles controlling the thumb).

2) **Joint ranges of motion during keyboard and mouse work** (refer to Page 3, Figures 2-4)**:** Range of motion measurements of six joints using a hand-held goniometer. Joints measured include:

- Neck flexion/extension/lateral flexion/lateral rotation.
- Shoulder–internal-external rotation/flexion extension/abduction.
- Elbow flexion/extension/pronation/supination.
- Wrist flexion/extension/radial/ulnar deviation.
- Thumb abduction at MCP (joint where the thumb meets the palm).
- Fifth finger abduction at MCP (joint where the fifth finger meets the palm).

Range of motion was obtained in the neck, shoulder, elbow, wrist, thumb, and fifth finger during two minutes of keyboarding and mouse work using a set typing and mousing script. Measurements were taken before and after the training program and were obtained using four certified hand therapists using goniometers.

Subjects N = 7:

The subjects were experienced keyboard/mouse users with computer-related RSI who were able to work without job restrictions of typing. This group was a subset of the 81 subjects studied in Phase II and was therefore comparable in demographic data, occupation, typing skills, pain patterns, and history.

Equipment:

- Surface EMG instrumentation (BIOMUSE created by Stanford Researcher R. Benjamin Knapp, Ph.D.)
- Joint range of motion changes measured with hand-held goniometers.
- Data collection system.
- Work station adjusted to current ergonomic standards (computer, standard 104-key keyboard, mouse, wrist rest, and chair).

Surface EMG and Joint Range of Motion-Group Outcome Results (Refer to Figures 1-4 on Page 3):

1) Surface EMG recordings of muscle activity decreased in the wrist and forearm, and increased in the neck, scapula, and trapezius muscle after training for both keyboard and mouse work.
2) Joint position range in the shoulder, elbow, and wrist decreased after training for keyboard and mouse work.
3) Joint position of the shoulder, elbow, and wrist changed toward neutral following training for keyboard and mouse work.
4) Joint position of the elbow is not at 90 degrees during keyboarding or mousing following the training. It is less than 90 degrees if we assume that a fully extended or straightened elbow is zero degrees.
5) Joint position of the wrist is not straight (i.e., not zero degrees) during keyboarding or mousing following training; it is slightly extended.
6) A decrease in neck, scapula, and trapezius muscle pain was seen despite the increased surface EMG activity recorded in these muscle groups.
7) 100 percent of the subjects reported less pain in all body parts recorded involving the neck and upper limb after training.

Together, the surface EMG and joint range of motion studies of the right upper limb and neck describe a significant change in the pattern of work performed by the wrist and fingers.

One sees: 1) the extreme joint angles (such as bending the wrists up or twisting the wrist sideways); 2) high muscle contraction forces of the fingers, wrists, and arms; and 3) wrist/finger repetitions being replaced with a fluid, relaxed, and coordinated movement of the whole upper limb, shoulder, and torso.

Each joint works around the mid-point of its full range of motion and each muscle works around its resting length. (The resting length is the length that a muscle fiber assumes when the whole limb is in its resting and balanced condition.) These are the changes which have occurred in the post-trained group. These biomechanical principles for joint and muscle function allow for maximum muscle activation, work efficiency, comfort and control such that no one joint or muscle group is overworked and becomes fatigued.

Net Effect

The net effect as seen in the Phase III study is:

1) A decrease in pain of the whole wrist, arm, and neck reported by 100 percent of the subjects.
2) A decrease in the right upper extremity muscle tension and contraction forces during typing and mousing assessed by using surface EMG measurements. Of note, the higher surface EMG recordings of the trapezius muscle in the neck and shoulder is likely in part due to the increased motion from using the shoulder muscles to move the arm rather than from isolated static muscle contractions which are associated with muscle fatigue and pain.
3) A decrease in the joint angle range of motion or excursion from the neutral position of the wrist, elbow, and shoulder during typing and mouse use such that they are maintained within the recommended safety guidelines for computer work.
4) The observation of the elbow angle being less than 90 degrees (assuming that a fully extended or straight elbow is zero degrees) and wrist angle being slightly extended (e.g. hand is raised up) is consistent with increasing the resting position of the hand and position of function of the upper limb for the performance of work (Brand 1985). The person can work more easily and for longer periods of time before fatigue occurs in this position.

Summary

In taking steps to reduce the likelihood of computer-related RSI, it appears that changing work habits is the most challenging aspect of treatment and training. Equipment needs and ergonomic considerations are important. However, teaching workers to use the mouse and keyboard—whatever the style of the equipment—more effectively may be more cost-effective and have better results in the long term.

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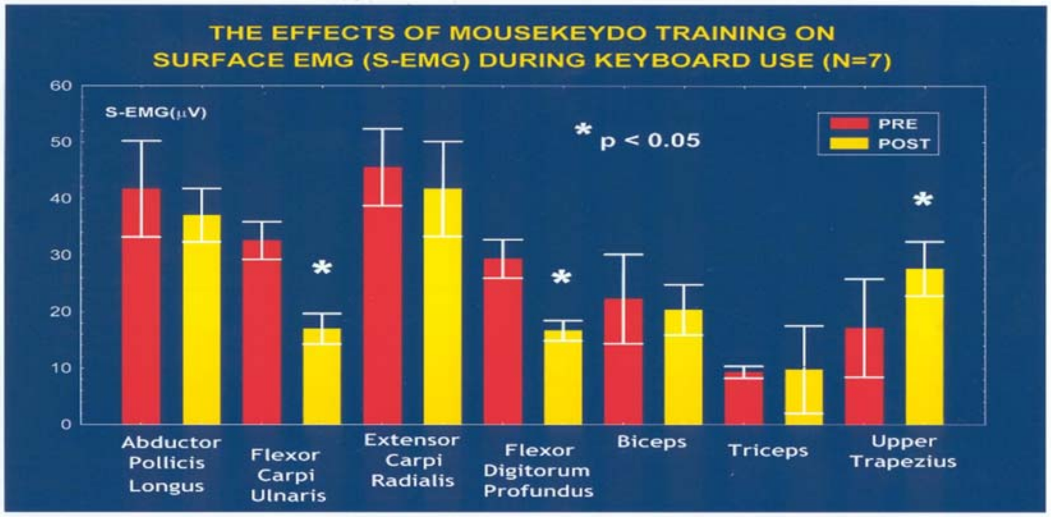
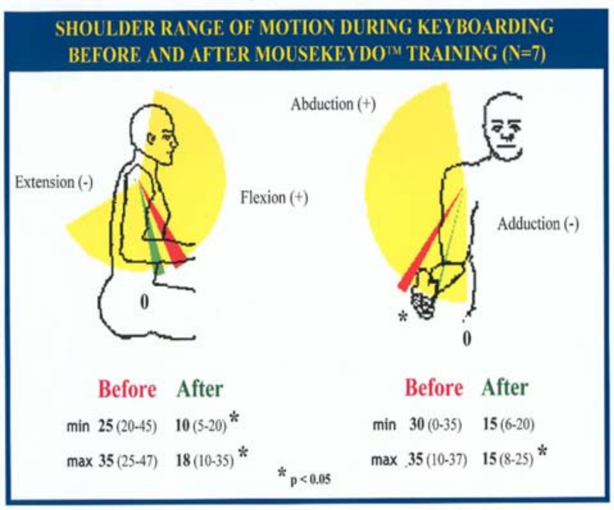
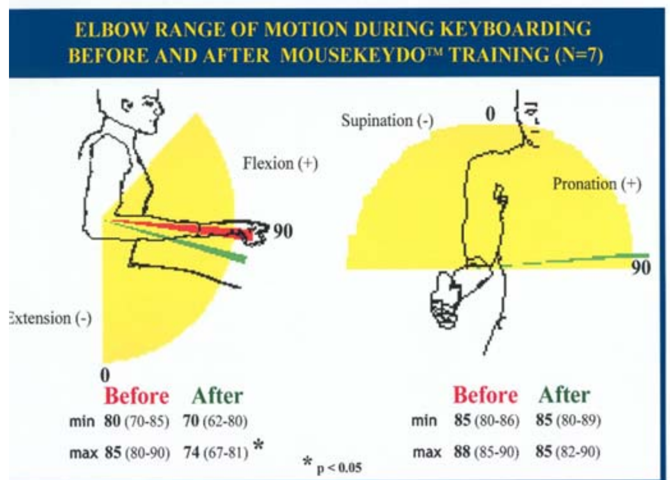
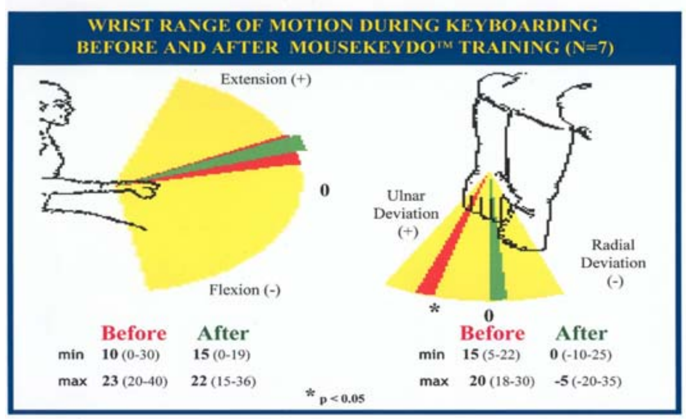


Figure 1: Surface EMG during keyboard work. Surface EMG root mean square recordings during two minutes of keyboarding on seven muscles of the right upper limb and neck before (red bars) and after (yellow bars) MouseKeyDo™ training. Dependent T tests were used to determine statistical significance with P < .05 indicated by asterisk (*).





Figures 2-4: Changes in range of motion for the shoulder, elbow, and wrist. Changes are denoted during two minutes of keyboarding before and after MouseKeyDo™ training in seven subjects. Joint position is expressed as a median followed by the minimum and maximum values of the data sample in parentheses. An (*) denotes statistical significance with p < 0.05. Yellow is the full range of motion, which the selected joint is capable of performing; red is the before-training range of motion for the selected joint; green is the after-training range of motion for the selected joint.



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