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Effects of the use of a special computer mouse The HandShoe Mouse

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Introduction - problems and observations

Based on fundamental biomechanical research it was noted that the level of forearm muscle activity varies depending on the type of computer mouse used.

EMG values showed that a supporting contour can realize significant reduction of activity in between muscle actions like switching and scrolling or moving the mouse over the desktop.

Next to the contour of the supporting surface, the plane angle variation from fully pronated to 90° supination, “handshake position” has a significant effect on muscle activity.

With a conventional mouse a combination of thumb, ring- and little finger is required to realize optimal control in the horizontal (X-Y) plane. By providing a supporting contour for hand palm and fingers, it was noted that gripping and pinching of thumb and fingers (m. extensor carpi radialis longus and brevis) to control the mouse in the X-Y plane was no longer necessary (1).



The supporting contour enables a near to fully relaxed flexor and extensor muscle position which is reflected by a significant reduction of the EMG signal. This contrary to the hovering finger position

required with a conventional mouse where the hand is fully pronated. This contour arch stabilizes the freely moving finger guaranteeing the joint's (PIP) movements in static and dynamic situations (2). Fingers (tips, close to the desktop) rest on the switches which follow the contour of the mouse. To switch only a light flexing action of the fingers is required whereby the majority of the switch action is at the finger tips.

A fully pronated hand and forearm (hand flat on the desk top) as well as a supination angle near to vertical (handshake position) forces hand and forearm in a strained position. Moving the hand sideways in a pronated position may lead to hypertrophy of the wrist flexor muscles (e.g. m. flexor carpi ulnaris). In some cases this may even lead to nerve compression (neuropathy) (3). In studies with respect to Chronic Compartment Syndrome (CCS) with keyboard operators, the arm pain was invariably worse in the mouse operating hand (4).

Vertical "handshake" type computer mice, generally assumed to provide a neutral hand position, have been re-evaluated in view of observed Interosseous Membrane (IOM) tautness. Anatomical *in vitro* studies suggest negative effects of such an assumed "neutral" forearm position.



Note, the IOM connects both forearm bones (Ulna and Radius) of which the Radius has an arched curvature, contrary to the Ulna. This results in the IOM being more or less stretched or relaxed depending on hand and forearm position. For example, in the "handshake" position the most stretched position of the IOM occurs, distance between the forearm bones is at its maximum. A slanted position of forearm and hand reduces this distance and relaxes the IOM (5).

Because most of thumb and index finger (long) muscles originate from the IOM, the assumption is justified that opposing muscles (antagonists) in using vertical mice may cause muscle disorders *in vivo* (6). Contrary to this, with a lightly slanted mouse position (around 25° - 30°), wrist and forearm at a natural angle, minimal forearm muscle activity is needed (7) (8) (9).

Results due to posture

As mentioned, a conventional mouse instigates gripping and pinching (m. extensor carpi radialis longus and brevis) next to hovering of the fingers above the switch buttons (m. extensor digitorum). Based on *in vivo* tests during field research, it is assumed muscle spasms in the deep neck muscles (mm. scaleni) may occur. This may result in a reduction of the space between first rib and Collar (Clavicle) bone, Costo-Clavicular space and lead to compression of nerves (brachial plexus) and blood vessels (subclavian artery and vein) (10) (11).

Exertion of (unnecessary) static forces like gripping, pinching and hovering (extensor loads) result in muscles acting continuously. The special motor units (type I muscle fibers) control these lesser forces and are continuously active resulting in irritation, also called Cinderella effect (12). Furthermore, studies compared the muscle energy metabolism of the finger extensor muscle assuming alterations due to impaired blood flow (energy metabolism). It is assumed that a deficit in energy production by oxidative pathways may exist in the affected muscles. Two possible explanations for this would be the partial and/or local reduction of blood supply and the reduction of the muscle oxidative capacity itself. Work-related pain in the finger extensor muscles may be associated with intracellular pH compartmentation during exercise, a build-up of metabolic wastes (13).

In general symptoms are:

- pain, numbness, and tingling in the pinky and ring fingers, and the inner forearm
- pain in the neck and shoulders
- signs of poor circulation in the hand or forearm
- weakness of the muscles in the hand

Conclusion

Based on the aforementioned, we may conclude that working in physically uncomfortable conditions, as well as the resulting metabolic waste due to working in such circumstances, may cause detrimental effects. According to us such effects can be avoided by means of providing fitting support, thus preventing the mentioned muscle overload.

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