

Ergonomic Motorized Keyboard

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Introduction

Repetitive typing and prolonged computer use have been associated with increased incidence of musculoskeletal disorders in the upper extremity. Disorders that have been connected to keyboard use include carpal tunnel syndrome, tendonitis and tenosynovitis.

Carpal Tunnel Syndrome (CTS) develops as a result of pressure on the median nerve at the wrist. The carpal tunnel is an anatomical space through which the median nerve and nine tendons pass from the forearm to the hand. CTS occurs when there is an increase in pressure within the tunnel. This pressure compresses the nerve causing numbness, tingling and pain in the hand and fingers. Prolonged postures and repetitive finger and wrist motion have been linked to the development of CTS (ASSH 2007).

Sunderland in his extensive work with nerve compression demonstrated that the vascular flow to the nerve is altered with compression. Prolonged postures and repetitive finger and wrist motion have been identified as causes of compression of the median nerve. Repetitive friction on the flexor tendons over a prolonged period of time had been found to increase production of synovial fluid in the tendon sheath and in the carpal tunnel (Lundborg 1982, Smith 1977). This compression over time can lead to ischemic changes in the sensory nerve fibers that slow conduction.

A foundational study by Serina, Tal, and Rempel (1999) identified prolonged wrist and forearm postures at non-neutral angles during keyboard typing as one of the major causes of CTS. Over the last several years various keyboard designs have emerged in the marketplace to address this problem. Keyboards have been designed to address the wrist and forearm angles during typing, and to limit the amount of finger motion by altering the slope and height. Several studies examine the effects of different keyboard designs on wrist and forearm posture, tendon excursion, and finger motion. Positive results are reported for split keyboard designs that are adjustable for lateral inclination. Among the many keyboard designs on the market some address the wrist position, others the forearm position and still others the finger motion.

Current Situation

To date there is no one design that addresses all the problems encountered with prolonged positioning in typing. Furthermore, all the current designs in the market, which place the hands and forearms in a static posture, are only adjustable to several static positions.

The Office of Safety and Health Administration (OSHA) has completed studies that show that the use of these static “alternative” or ergonomic keyboards show no difference in the incidence of CTS or other RSI-related injuries (NIOSH Publication 97-141). OSHA further reports that RSI incidence has reached such epidemic proportions that RSI represents 62 percent of all North American Workers Compensation claims, and results in \$15-\$20 Billion in lost work time and WC claims each year (PR Newswire, January 18, 2005).

Furthermore, the Bureau of Labor Statistics (2005) reports that 26 million Americans suffer from RSI with 1.8 million having injuries severe enough to require a worker to miss at least one day of work. Topping the list for the median number of days workers are sidelined is carpal tunnel syndrome, which causes injured workers to be out of work an average of 28 days.

The medical causation of RSI has two primary culprits a) inflammation of tendons as a result of static repetition of movement, and b) inadequate blood flow. Alan Hedge, PhD, the director of ergonomic research at Cornell University, says that modern keyboards have actually made the work more risky because they don't allow for the occasional respites from typing that you once got from using a typewriter.

These factors would suggest that a possible solution would include a motorized keyboard that would study each usage pattern and quantity, and then would methodically but gradually move the wrist and forearm through a dynamic arc of motion in all three degrees of freedom: radial/ulnar deviation, forearm pronation/supination, and wrist flexion/extension. Such a device would avoid prolonged posture in any one position, and may minimize the cumulative effects of repetitive use.

The Healing Power of Motion

Mobility has long been supported by the medical community as being beneficial to patients for maintaining a healthy lifestyle. Conceptually, motion may be beneficial as well for situations where irritation or inflammation may result from the static repetition of human interactive devices typically involved with the use of computers.

Our objective should be to develop solutions that would actually help to avoid such injuries rather than simply trying to repair the damage caused by them.

Movement and RSI

The application of movement by a keyboard, or other computer devices, to reduce the incidence of RSI and CTS is a relatively new concept. The standard responses by the peripherals industry in the past to Repetitive Stress Injury (RSI) – of which CTS is only one form of such injuries – has been targeted to affecting the *position* of the hands as the cause of the injury. Many peripheral solutions that were then brought to the market have simply placed the user's hands in what they believed were more “natural” angles. As OSHA concluded, the resulting medical

benefits were negligible. Changing the hand position statically simply changed the angle within which the tendon irritation developed.

However, if the device could be made to periodically but subtly change its own positioning, with the hands following, the tendons and ligaments would be casually readjusted so that the irritation location on each would be slightly but significantly changed.

It soon became apparent that it was the *repetition*, not the *position*, of the hands that was the culprit. If the repetition could be avoided, then the load on the tendons involved would be spread across their full surface, thereby eliminating the resulting pressure, irritation, inflammation and pain.

To reduce the symptoms of RSI and CTS, any device would have to be able to provide movement across all three axis – vertical, horizontal, and radial – in order to provide optimum results.

The Difference Maker

No two people use these devices in the same fashion. Everyone's style, approach, frequency, and speed all vary. In order to provide the most relief from the repetitive stress, any such truly ergonomic device would have to have enough intelligence to recognize the traits of each individual user and make the adjustments necessary that are specific to that user. Today's computer technology certainly has the capabilities of providing such a solution, but it will take a totally focused initiative to produce products that can actually make the difference for a wide set of users.

Summary

Any device that can incorporate all of the conditional factors now recognized as being causative of RSI and CTS should have the ability to reduce the incidence of such injuries.

They would have to therefore:

- Provide periodic but imperceptible re-positioning of the hands and wrists
- Provide such movements as would encompass all three angles of axis
- Provide positioning that is significant enough to provide benefit without being extreme
- Provide intelligent evaluation of each user and make specific accommodation as required
- Provide a superior comfort level in all positions made available by the device

It would seem reasonable that such movement-based devices could be developed with enough intelligence and healthy movement so that as many people as possible can potentially receive the benefit of minimizing their risk of incurring Carpal Tunnel Syndrome.

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