

# Ergonomic Strategies for Computer Users With Upper Limb Problems

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**M**ANY AMERICANS SPEND SEVERAL hours a day using a computer. Most take typing and mouse use for granted; however, these tasks may be painful, harmful, or impossible for people with upper limb problems. Although ergonomic interventions benefit users, the science supporting them may be poorly understood by both patients and doctors and does not always play a role in the rehabilitation process.

## FUNDAMENTALS

Ergonomic optimization relies partly on components (eg, chairs, keyboards, and monitors) that can be adjusted to accommodate an individual's unique habitus, responsibilities, limitations, and other factors. The optimal workplace position involves neutral positioning of all major joints, with the computer monitor placed at the user's focal length (for which "arm's length" is an imprecise approximation) and slightly below the level of the eyes. A properly positioned keyboard tray can eliminate the need for elbow and wrist support (Fig. 1). If the limbs must be supported, bony prominences and superficial nerves at the elbow and wrist should be padded. Sufficient space should allow for freedom of movement in and around the chair and on the desk.

## CARPAL TUNNEL SYNDROME

A myriad of desktop devices exist to aid users without healthy upper limbs; searching the Internet shopping

site [Amazon.com](http://Amazon.com) for "ergonomic mouse" or "ergonomic keyboard" yields thousands of results. This proliferation of devices represents some benefit to users, but is also the result of shrewd marketing and widespread misunderstanding of carpal tunnel syndrome, among both lay users and physicians.<sup>1</sup> A large body of scientific work suggests that carpal tunnel syndrome is more related to genetics, age, female sex, obesity, and type 1 diabetes mellitus than it is to repetitive use of the hand.<sup>1</sup>

Although typing and mouse use are unlikely to cause carpal tunnel syndrome, they may unmask or exacerbate it. Direct pressure on the volar wrist as well as wrist flexion and extension increase hydrostatic pressure in the carpal tunnel and may irritate the median nerve.<sup>2</sup> These observations support, in theory, the use of any device that reduces pressure on the volar wrist or maintains the wrist in a more neutral position. Such devices include neutralizing braces, desktop bumps or pads, and specially designed mice and keyboards (Figs. 2, 3). Many specialized keyboards and mice position the user's shoulders and forearms more neutrally and thereby reduce ulnar deviation of the hand, prevent gravity from flexing the wrist, and reduce direct pressure on the carpal tunnel. In addition to reducing pressure on the median nerve, forearm and wrist neutralizing devices, in general, may reduce or at least redistribute muscle fatigue.<sup>3</sup> Care must be taken to ensure ideal forearm position is not bought at the cost of the shoulders and neck. Bumps and pads may also solve one positioning problem and create another, especially if used incorrectly. Users, for instance, may rest their palms rather than their wrists on common keyboard pads, trading wrist flexion for extension (Fig. 4). Enthusiasm for neutralizing and positioning devices must be tempered by the fact that little prospective randomized data support their use.<sup>4,5</sup> As an ergonomist, the senior author (E.S.K.) eschews them whenever possible, preferring to rely on education and behavior modification.

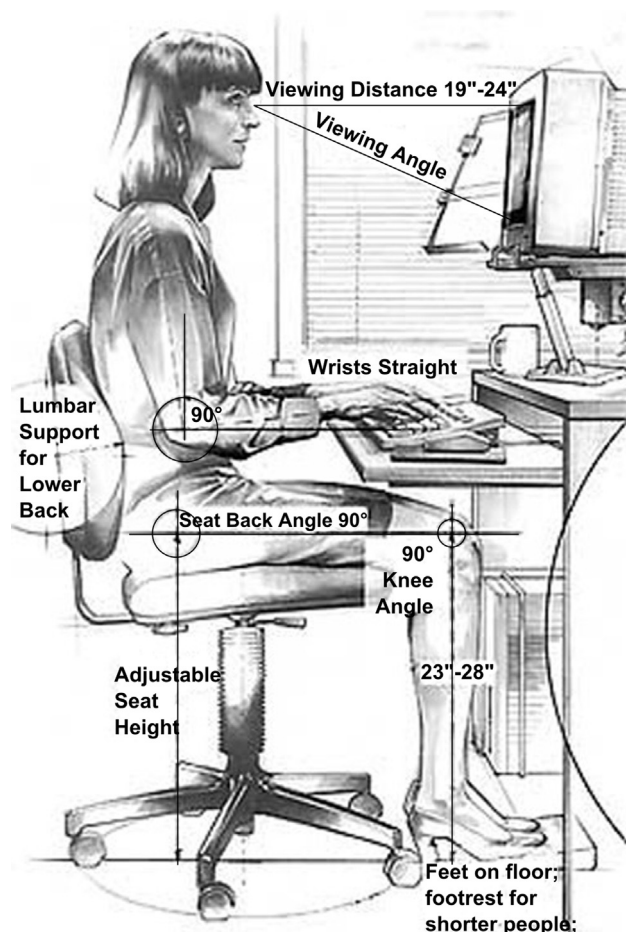
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**FIGURE 1:** Optimal ergonomic positioning of a workstation. Note that the hands float over the keyboard and that the elbows and wrists are unsupported. (This file is made available under the Creative Commons CC0 1.0 Universal Public Domain Dedication [http://en.wikipedia.org/wiki/Human\\_factors\\_and\\_ergonomics#/media/File:Computer\\_Workstation\\_Variables\\_cleanup.png](http://en.wikipedia.org/wiki/Human_factors_and_ergonomics#/media/File:Computer_Workstation_Variables_cleanup.png).)

## ARTHRITIS

After carpal tunnel syndrome, arthritis is perhaps the second most common chronic condition relevant to computer users. Affected people report pain as well as difficulty using standard interface devices, for example, patients with rheumatoid arthritis may be unable to position their forearms in pronation or accurately strike keys. People with arthritis may appreciate larger, joystick-style, or trackball-type mice (Fig. 5). Likewise, large-key keyboards and typing sticks may be beneficial. The Ergonomic Assessment Tool for Arthritis (Appendices A and B, available on the *Journal's* Web site at [www.jhandsurg.org](http://www.jhandsurg.org)) helps patients and occupational therapists collaborate and may aid in introducing specific interventions.



**FIGURE 2:** An ergonomic mouse with a track-ball feature. Note that this mouse positions the user's hand in less pronation than a standard device.

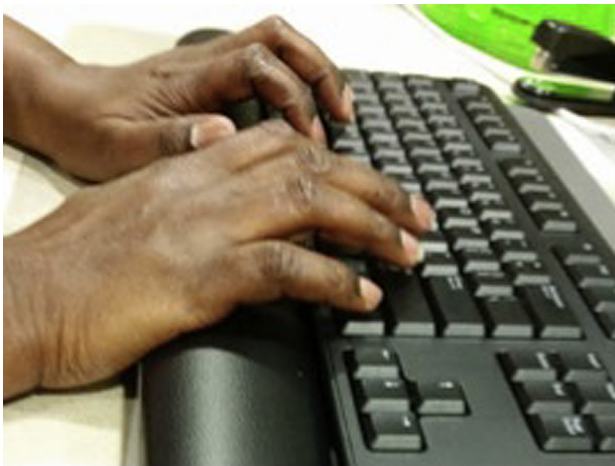


**FIGURE 3:** An ergonomic keyboard. Note that this keyboard positions the hands in less pronation, elevates the wrist to the level of the keys, and separates the hands. The wrists are placed in less ulnar deviation and the shoulders in less internal rotation.

## OTHER CONDITIONS

People who wear wrist braces either after surgery, because of an injury, or for a chronic condition, may prefer a dorsal orthosis allowing for cutaneous feedback from the palm and a so-called “rear-hump” mouse with an eccentric rather than a hemispherical profile (Fig. 5).<sup>6</sup>

For people with very limited use of their fingers, at least one device functions as a “keyless keyboard” (Fig. 6). People with more extensive upper



**FIGURE 4:** Improperly placing the palms on a keyboard bump positions the wrists in extension.



**FIGURE 5:** A rear-hump mouse, with an eccentric rather than a hemispherical profile.



**FIGURE 6:** A keyless keyboard. Users select characters by pushing the 2 “orbs” in combination. (Used with permission of Blue Orb, Inc.)

limb problems may benefit from speech recognition programs<sup>7</sup> or devices designed to interface with the feet or head. People with unilateral problems may simply prefer to train the other hand, perhaps with the assistance of software facilitating 1-handed typing.<sup>8</sup>

### EDUCATION, BEHAVIOR MODIFICATION, AND COLLABORATION

Ultimately, ergonomic optimization relies not only on equipment but also on education and behavior modification. For instance, teaching a user to float the

wrists over a standard keyboard may be preferable to an expensive alternative device or a problematic bump. Even people without upper limb problems will be most comfortable at the computer if they rest or change tasks periodically. Simple “micobreaks” in which users stand and stretch for 20 seconds at roughly 20-minute intervals may be beneficial.<sup>9</sup> Likewise, computer users may do well to obtain 2 slightly different keyboards and 2 slightly different mice. Periodically alternating devices and even switching which hand users operate a mouse with may alleviate or forestall fatigue. Computer users should be referred to the Occupational Safety and Health Administration’s Website on optimization of computer workstations for guidelines, checklists, and assessment tools.<sup>10</sup>

Depending on the severity of their condition, computer users with upper limb problems may benefit from collaboration between themselves, a hand surgeon, a therapist, and potentially, an ergonomist. It is often the case that a user thinks little of the physical relationship to the desk space, and hand surgeons are likely to have little knowledge of their patients’ working conditions. The success of any ergonomic intervention relies, however, on an assessment of both the user and their equipment, and a therapist and/or ergonomist may be invaluable in this regard. Photographs of the user at the desk, measurements of furniture and components, as well as an inventory of equipment and devices are useful, especially if a visit to the patient’s workplace is impossible.

- Ergonomics is the study of human physical interaction with the environment, and ergonomic principles should play a role in the care of any computer user with an upper limb problem.
- Computer use may unmask or exacerbate carpal tunnel syndrome but is unlikely to cause it.
- Carefully chosen devices may benefit computer users with upper limb problems such as carpal tunnel syndrome or arthritis, although little high-quality data exist to guide decision making in this regard.
- Sophisticated interventions are available for computer users with severe upper limb problems.
- Education, behavior modification, and collaboration are as important or are more important than special devices in the care of computer users with upper limb problems.

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