Carpal Tunnel Syndrome Among Employees at a Window Hardware Manufacturing Plant

Health Hazard Evaluation Series

by Susan Burt, MS, RN

In October 1988, investigators from the National Institute for Occupational Safety and Health (NIOSH) responded to a request from the management of a window hardware manufacturing facility to evaluate carpal tunnel syndrome (CTS) among employees in the assembly department. The main objective was to make recommendations to minimize ergonomic risk factors for CTS in this workplace. Jobs were evaluated for repetitiveness, awkward wrist and arm postures, and muscular force requirements.

Epidemiologic studies reveal a strong association between highly repetitious and forceful work and CTS, as well as other cumulative trauma disorders (Silverstein, 1986). Non-neutral joint postures put limbs at a biomechanical disadvantage, requiring more force to accomplish the same task (Armstrong, 1987).

Wrist flexion and extension can cause increased friction of the finger flexor tendons against the carpal bones or the tough ligament that lines the carpal tunnel, resulting in inflammation (Armstrong, 1983) and increased pressures within the carpal tunnel (Szabo, 1989). CTS develops when the median nerve becomes compressed in the carpal tunnel, resulting in impaired sensation and function of the first 3½ fingers of the hand.

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The facility requesting the review manufactures window balance systems from stamped, roll form aluminum or extruded vinyl. Twenty-eight female employees worked on several assembly lines to produce five products. OSHA 200 logs were reviewed for hand/wrist disorders, including: CTS, Guyon's canal syndrome (similar to CTS, but affecting the ulnar nerve), and tendinitis. The annual incidence rate for hand/wrist disorders was 23.4 per 200,000 hours worked, compared to 14.8 in the fabricated structural metal product industry as a whole (Bureau of Labor Statistics, 1988).

All of the job analysis data were collected by a review of videotapes in real time and at slow speeds. Repetitiveness was assessed by measuring two parameters—cycle or subcycle time and manual manipulations per day.

Cycle time measures the frequency of repetitive movements and was calculated by averaging at least 10 cycles. Cycle time begins with a movement and ends with the same movement on the next item being assembled.

In some cases the product was assembled in batches: the worker performed each task element separately on all units in the batch before proceeding to the next batch. In this case, subcycle time—the time required to perform a given task element on a per piece basis—provides a better estimate of repetitiveness. The number of manual manipulations made per day was determined by counting the number of hand/wrist postures that deviated from neutral for each unit assembled, and multiplying this value by the number of units assembled by the worker during the shift. Level of repetitiveness was categorized as low (less than 10,000 movements per day), medium (10,000 to 20,000 movements per day), and high (more than 20,000 movements per day).

Extreme wrist postures were defined as: flexion (>75°), extension (>50°), radial deviation (>10°), and ulnar deviation (>20°). Extreme shoulder postures were defined as: flexion (>90°), extension (>20°), and abduction (>90°).

Muscular force exerted was evaluated subjectively, except for two particularly difficult tasks. A calibrated force gauge was used to quantify the force required to perform these two tasks: sliding tubes into window liners, and pulling and hooking springs onto window liners.

All of the assembly jobs involved risk factors commonly associated with CTS: repetitive hand/wrist manipulations, in combination with varying degrees of force and deviated wrist positions. A policy of job rotation was in effect in the assembly department at the time of the health hazard evaluation. Teams of workers rotated from one assembly job to the next every 2 hours in an attempt to broaden job tasks.

Job rotation was not a successful intervention in this workplace, however, because the jobs involved similar ergonomic risk factors. Jobs were rated by level of ergonomic stress for the purpose of setting priorities for intervention to eliminate or reduce risk.

Eight of the 12 jobs evaluated were highly repetitive (>20,000 movements/day). It was recommended that these jobs either be slowed down or shared with additional workers on the line.

Extreme postures were documented for all task elements of each of the 12 jobs performed in the assembly department. Wrist extension; ulnar deviation; shoulder flexion, extension, and abduction; pinching; and extreme reaching were noted. Recommendations to correct these postures included relocating parts, using appropriately designed bins to hold parts, and conveyors to transport finished parts.

Two hand tools had been devised to facilitate assembly tasks. NIOSH investigators recommended improving these tools, with longer, larger, padded handles to avoid pressure on the palm, and changing the angle of the handle to eliminate the need to bend the wrist.

Recommendations to decrease force in the two tasks that were determined to require high force included partial automation. The company already had plans to use a device to pull the springs, which should greatly reduce the force requirements of that task. Design modification of parts was recommended to decrease the force required to assemble them.

It was also noted that some of the material being assembled was defective. Some liners were bowed and some holes were incompletely punched out. More force was required to insert parts onto bowed liners, and screwdrivers were used to open incompletely punched holes. Working with defective materials requires increased force and multiple attempts to assemble parts, while slowing the assembly of the products. Better quality control of materials supplied to the assembly department was recommended.

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This case report is a summary of a health hazard evaluation conducted by Susan Burt, RN, MS, James Boiano, MS, CIH, and Daniel Habes, MSE. More information, including a full final report (HETA 88-361-2091), may be obtained by contacting the National Institute for Occupational Safety and Health, 4676 Columbia Parkway, Cincinnati, OH 45226 ([800] 35-NIOSH).