

# SENSORY NERVE RESPONSES TO ACUTE VIBRATION ARE FREQUENCY-DEPENDENT IN A RAT TAIL MODEL OF HAND-ARM VIBRATION SYNDROME

Kristine Krajnak,<sup>1</sup> Stacey Waugh,<sup>1</sup> G. Roger Miller,<sup>1</sup> and Michael L. Kashon<sup>2</sup>

<sup>1</sup>Engineering and Control Technology Branch, Health Effects Laboratory Division

<sup>2</sup>Biostatistics and Epidemiology Branch, Health Effects Laboratory Division

National Institute for Occupational Safety and Health (NIOSH), Morgantown, WV

## Introduction

Occupational exposure to hand-arm vibration through the use of powered handtools can result in reductions in tactile sensitivity. Acute exposures to vibration cause shifts in vibrotactile thresholds in exposed fingers that are affected by the frequency of the exposure, with exposure to midrange vibration frequencies (i.e., around 125 Hz) producing the greatest shifts [Maeda and Griffin 1994]. We have demonstrated that acute vibration exposure at 125 Hz results in a transient increase in sensory nerve thresholds to a 2,000-Hz transcutaneous stimulus in a rat tail model of hand-arm vibration syndrome [Krajnak et al. 2007]. The goal of this study was to determine how repeated exposures to vibration at frequencies that produce different biodynamic responses affect sensory nerve function in our rat tail model.

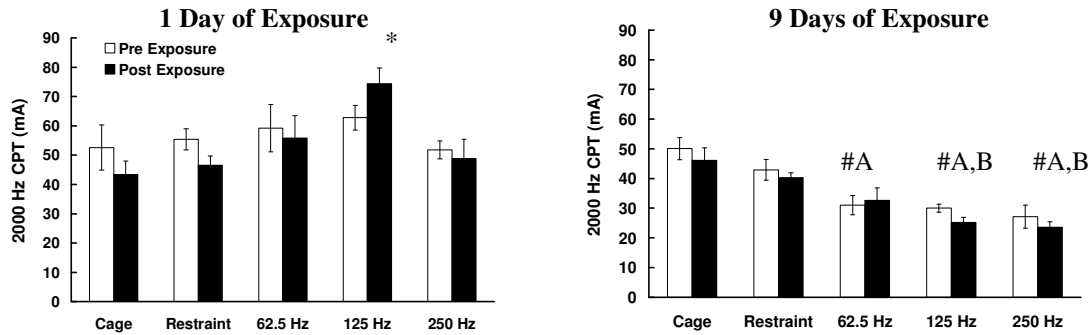
## Methods

**Animals.** Male Sprague Dawley rats (8 weeks of age, n = 5 per group) were housed in AAALAC-accredited facilities. All procedures were approved by the NIOSH Animal Care and Use Committee and were in compliance with CDC guidelines for the care and use of laboratory animals. Vibration exposures were performed by restraining rats in a Broome-style restrainer and securing their tails to a vibration platform using 6-mm-wide straps that were placed over the tail every 3 cm. Restraint control animals were treated in an identical manner except that the tail platform was set on isolation blocks instead of a shaker. Rats were exposed to 4-hr bouts of vibration or restraint for 10 consecutive days at 0, 62.5, 125, or 250 Hz with a constant acceleration of 49 m/s<sup>2</sup> root-mean-square. Previous work in our laboratory has shown that vibration exposure at these frequencies and acceleration produce different magnitudes of transmissibility to the tail [Welcome et al. 2006]. An additional group of animals served as cage control rats.

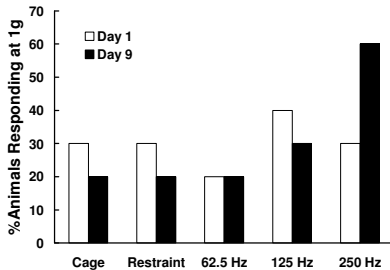
**Current perception thresholds (CPTs) and mechanoreceptor sensitivity.** Sensory nerve function was assessed by measuring CPTs with a Neurometer (Neurotron, Inc., Baltimore, MD). Transcutaneous nerve stimulation at 2,000 Hz was applied to the C10 region of the tail to determine the effects of vibration on A $\beta$  nerve fiber sensitivity. The intensity of the stimulus was automatically increased in small increments until the rat flicked its tail. A $\beta$ -nerve fibers are large-diameter, myelinated nerve fibers that carry information from mechanoreceptors to the central nervous system. Tests were repeated until the animals displayed two responses that were within 2 CPT (or 0.02 mA) of each other (two to three tests per animal). To determine if changes in sensory nerve responsiveness were accompanied by changes in mechanoreceptor sensitivity, the response to pressure induced by the application of 1- and 10-g von Frey filament was assessed. If animals flicked their tail, they were responsive; if not, they were nonresponsive. CPT and mechanoreceptor sensitivity tests were performed before (pretest) and immediately after (posttest) the vibration exposure on days 1 and 9 of the exposure.

**Data analyses.** CPT data were analyzed using a mixed model three-way (condition  $\times$  days of exposure  $\times$  pre/post exposure) ANOVA where animal served as a random variable. The number of animals responding to stimulation with the von Frey filaments was analyzed using contingency table chi-square tests. Differences with  $p < 0.05$  were considered significant.

## Results



**Figure 1.—CPTs after vibration exposure.** After 1 day of exposure, vibration at 125 Hz resulted in an increase in the 2,000-Hz CPT threshold (\*greater than preexposure,  $p < 0.05$ ). After 9 days of exposure, CPTs were reduced in all rats exposed to vibration (# less than day 1,  $p < 0.05$ ). In addition, vibrated animals displayed lower thresholds than control animals after 9 days of exposure (A: different from cage controls; B: different from restraint controls,  $p < 0.05$ ).



**Figure 2.—Percentage of animals responding to mechanoreceptor stimulation with a 1-g von Frey filament after 1 or 9 days of vibration.** The percentage of animals responding to stimulation with the filament was higher after 9 days of vibration exposure at 250 Hz than after 1 day ( $\chi^2$ ,  $p < 0.04$ ). No changes were seen with 10-g stimulation.

## Discussion

- As previously shown [Krajnak et al. 2007], a single exposure to vibration at 125 Hz results in an increase in the 2,000-Hz CPT. Similar responses to acute vibration are also seen in humans [Maeda and Griffin 1994].
- After 9 days of vibration exposure, 2,000-Hz thresholds were lower in vibrated than in control or restrained rats. In contrast, changes in mechanoreceptor sensitivity were seen only in rats exposed to 250 Hz, which is the frequency that generates the greatest biodynamic response in the tail [Welcome et al. 2006].
- Increased sensitivity to mechanical stimuli may serve as an early indicator of vibration-induced nerve damage.

## References

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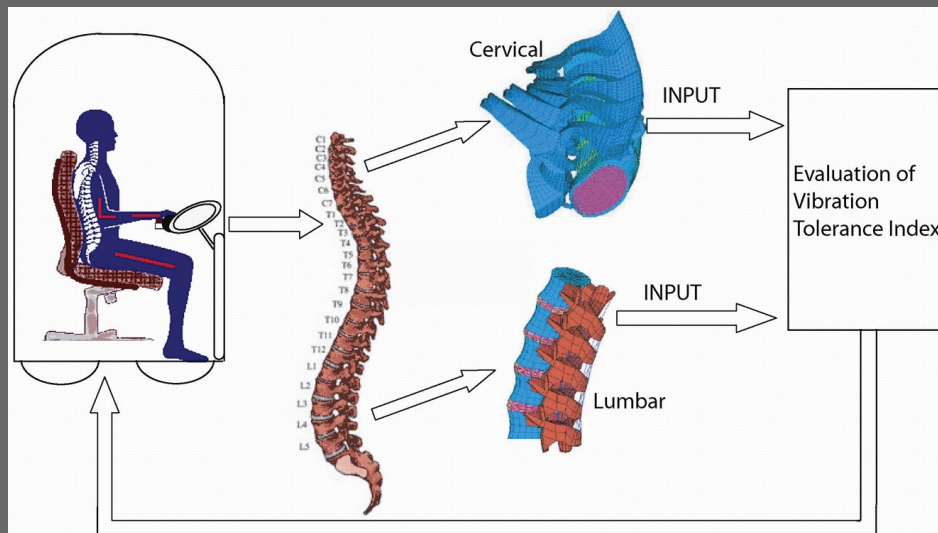
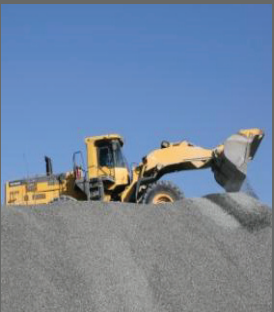
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