HAND ARM VIBRATION

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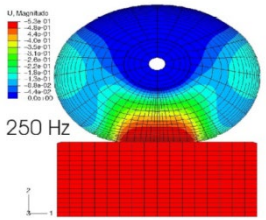
Effects of applied pressure on sensorineural and peripheral vascular function in an animal model of hand-arm vibration syndrome.

Kristine Krajnak, Christopher Warren, Xueyan Xu, Stacey Waugh, Phillip Chapman, Daniel Welcome and Renguang Dong

Physical Effects Research Branch, Health Effects Laboratory Division, National Institute for Occupational Safety and Health, Morgantown, WV, USA

Background

The relationship between biomechanical responses and biological effects have not been clearly understood and quantified.



(Wu et al., 2003)

Hand-transmitted Vibration Hazards:
- Vibration type
- Vibration magnitude
- Vibration duration
- Vibration frequency
- Vibration direction

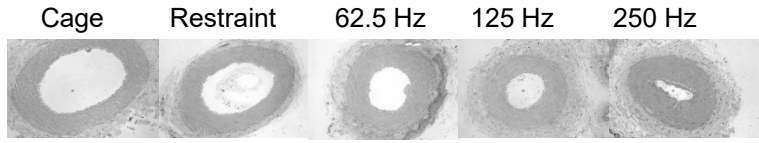
Biomechanical Responses:
Static and dynamic tissue stress, strain, energy absorption, etc.

Other biomechanical hazards: grip force, push/pull force, awkward hand or arm postures, etc.

Individual Factors and Environmental:
anthropometry, physical strength/condition, age, gender, past injury histories, smoking, leisure activities, temperature, duration of work day etc.

Biological Effects:
psychophysical, physiological, and pathological effects

HAVS

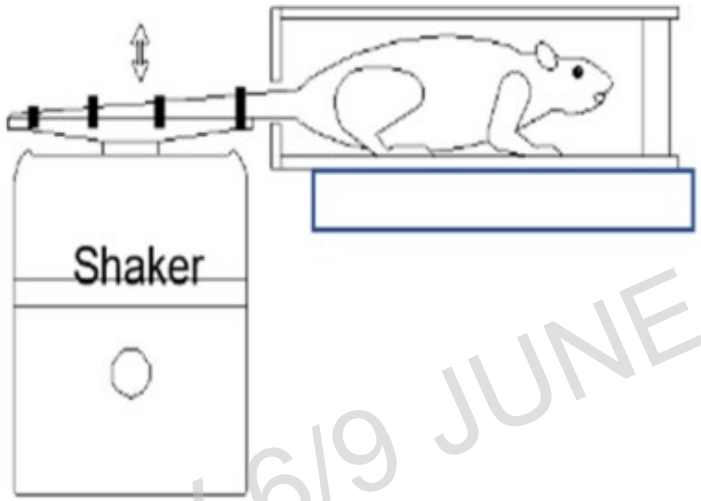


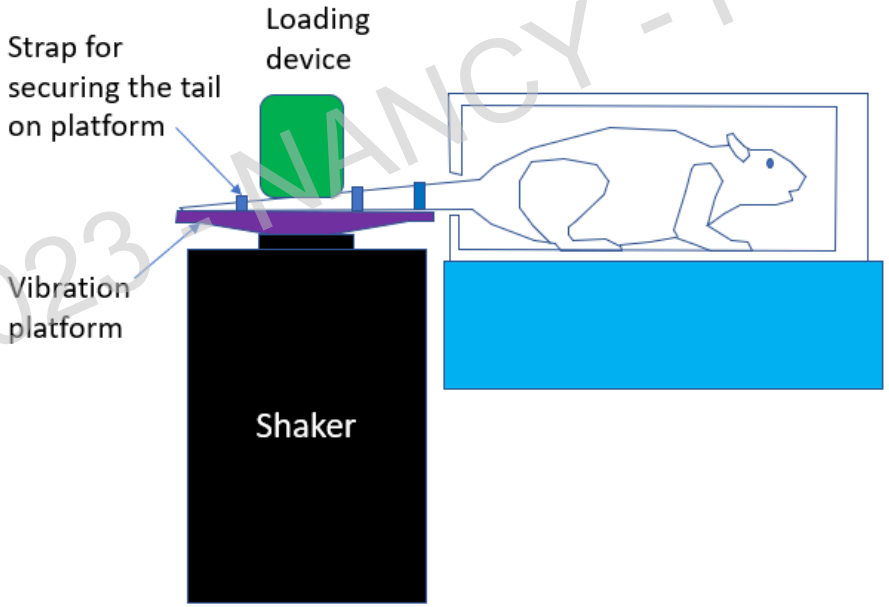
(Krajnak et al., 2010)

Biomechanical Process

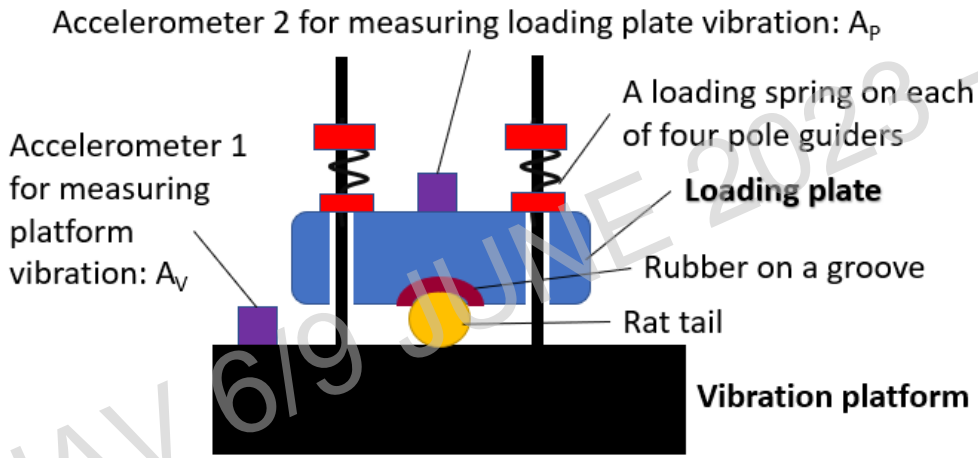
Biological Process

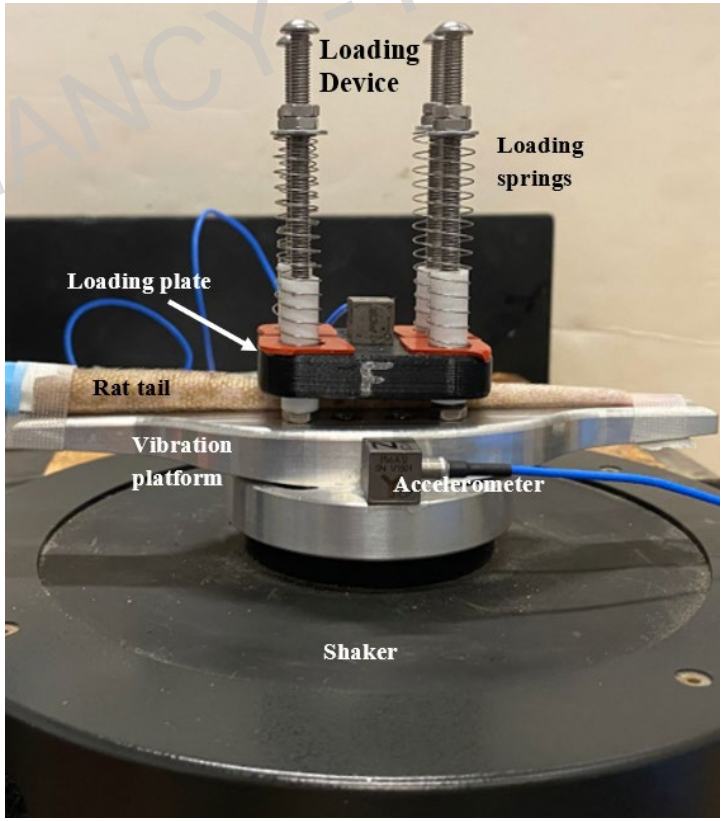
NIOSHs Animal Model





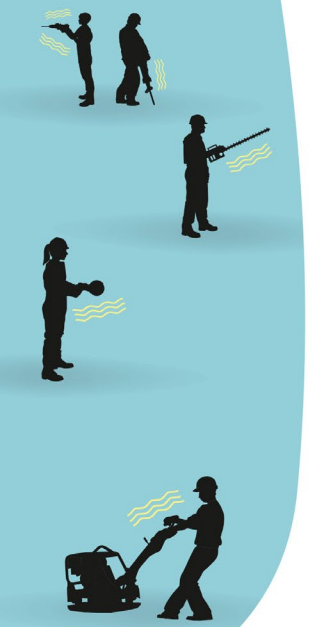
Design of the new rat-tail model



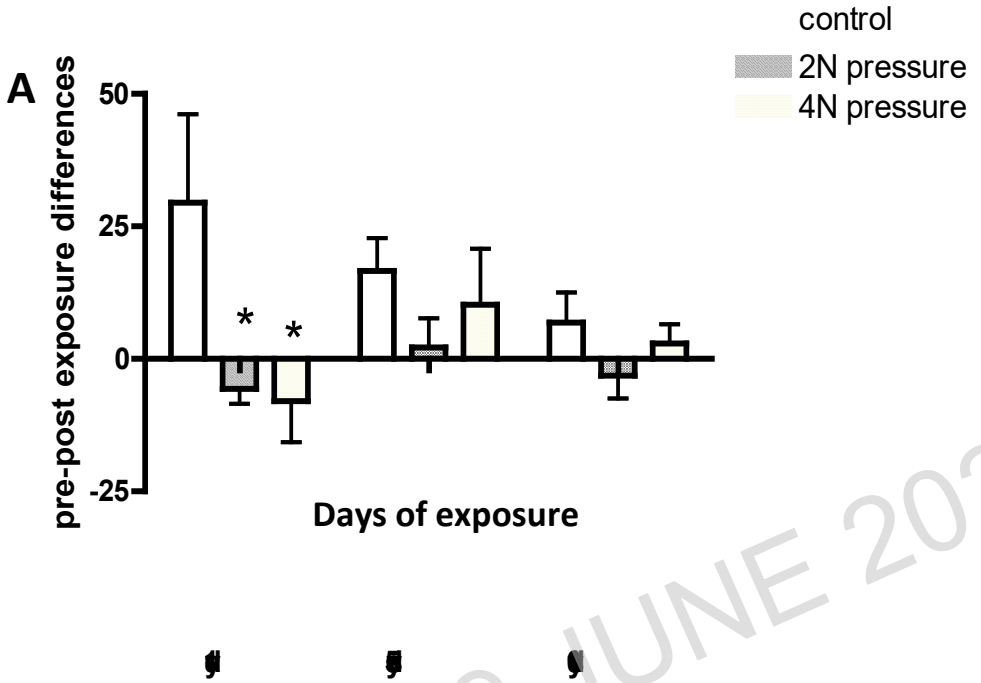


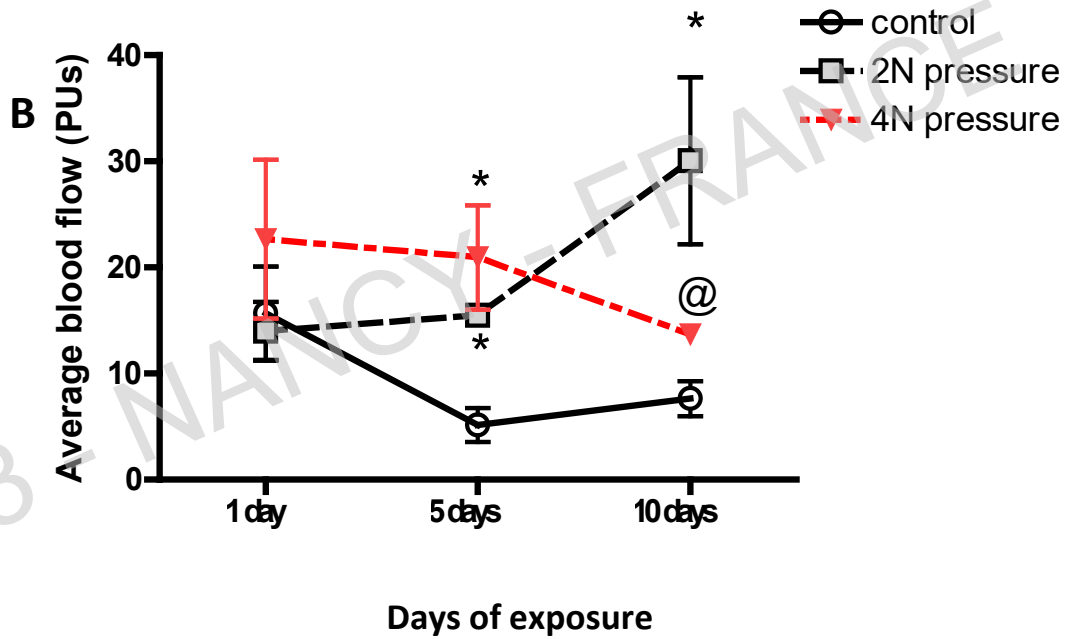
Determining the effects of applied force on peripheral vascular and sensorineural function

- N= 18 male Sprague Dawley rats,8 weeks of age at the beginning of the experiment.
- Assigned to a control group, 2N applied force or 4N applied force (N = 6/group)
- Each exposure was 4h/day for 10 consecutive days
- Measures
  - Body weight (days1, 5 and 10 exposure)
  - Blood flow (laser doppler, days 1, 5 and 10, pre- and post-exposure)
  - Microvessel responsiveness to vasoconstricting and dilating substances
  - Current Perception Threshold (CPT or transcutaneous electrical stimulation, pre-post exposure on days 2 and 9)
  - Randall-Selitto Pressure test (days 1, 5 and 10 pre- and post-exposure)



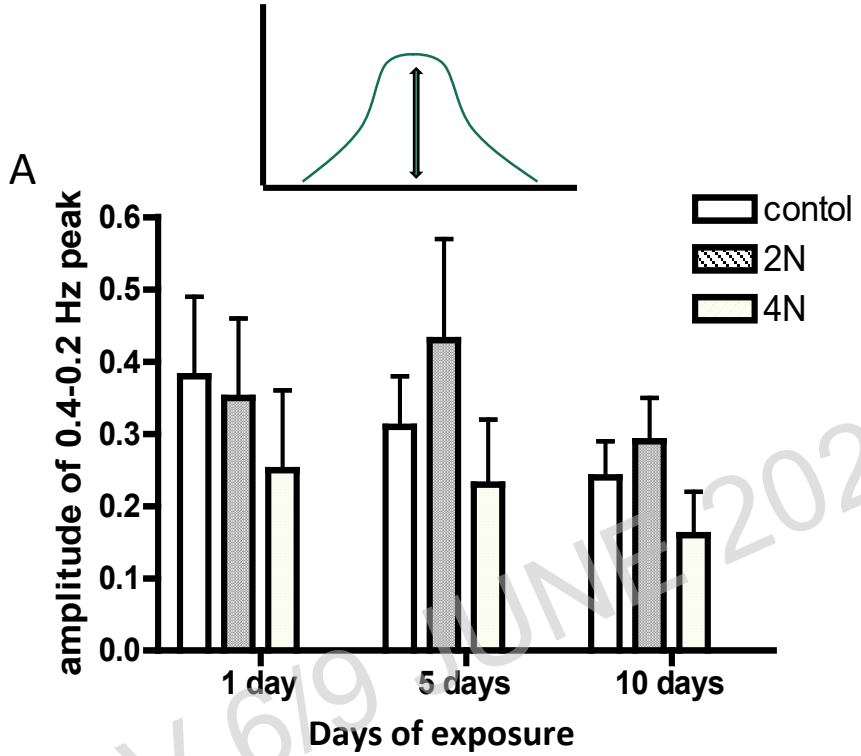
Effects of force on blood flow [average perfusion units (PUs) measured by laser doppler]

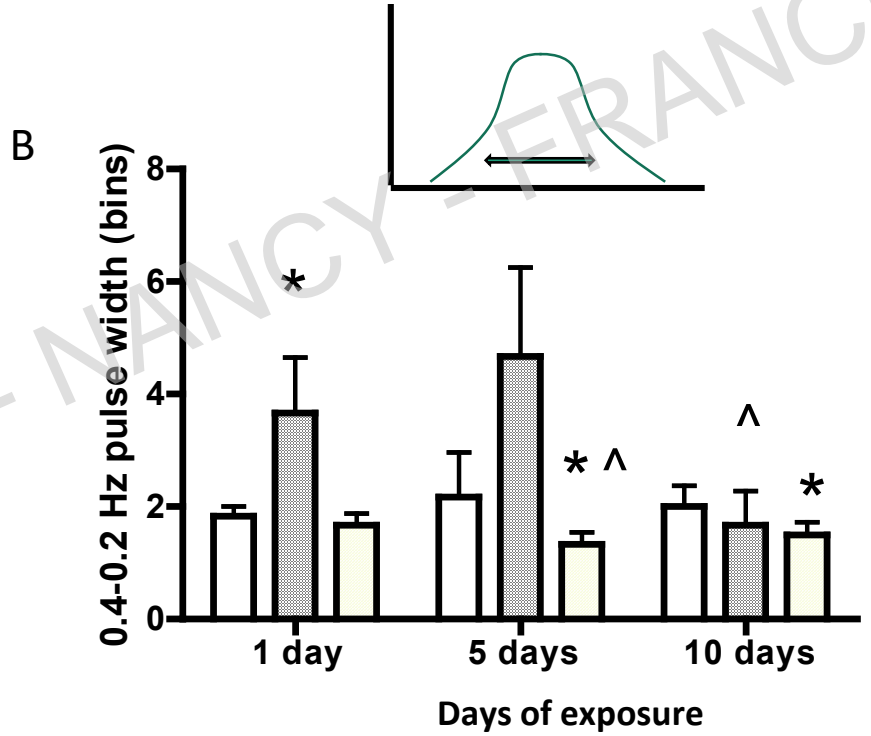




Exposure to applied force resulted in acute reductions in blood flow (A), but these changes occurred with repeated exposures. When average pre-exposure blood flow was analyzed across days, pre-exposure blood flow in force exposed animals was increased after 5 and 10 days of exposure, however, the effect was more prominent after 10 days (B) .

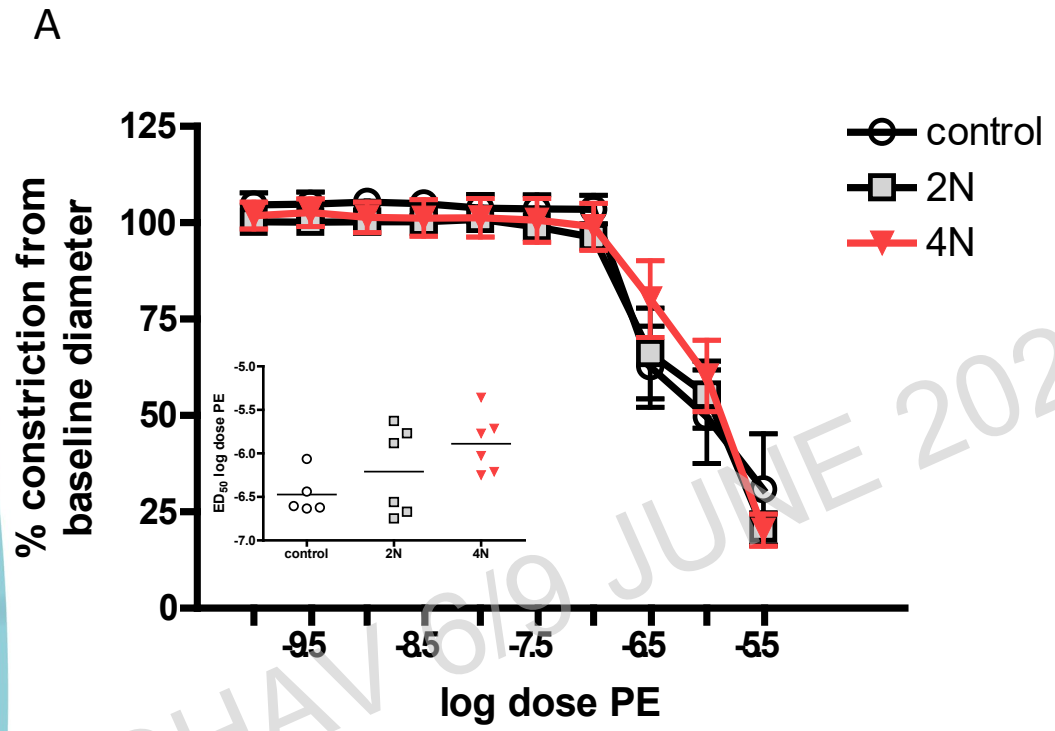
Effects of applied force on pulse rate calculated from the laser doppler

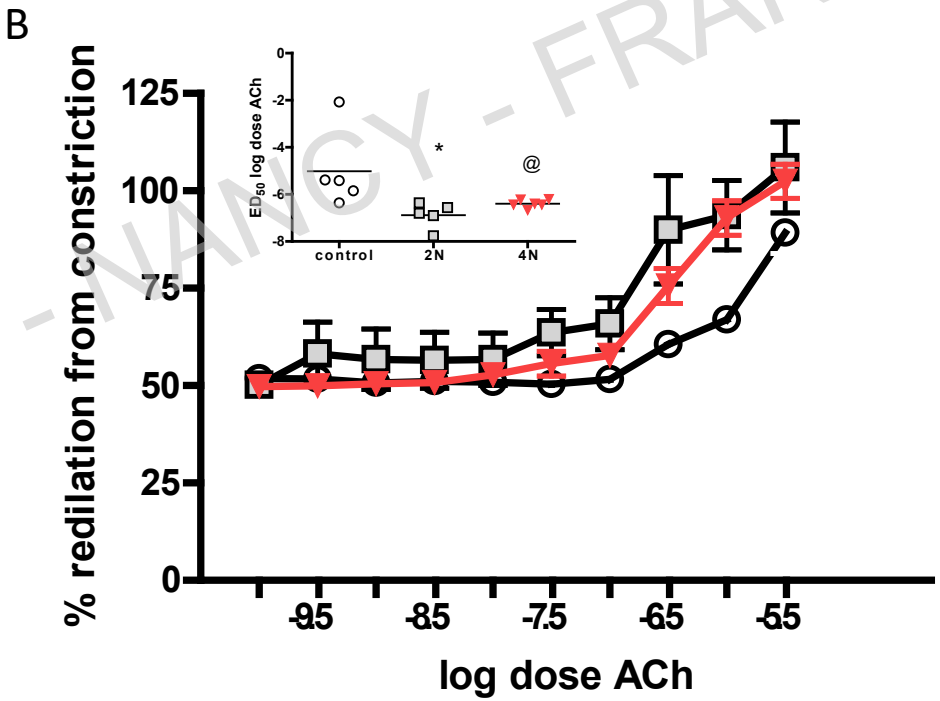




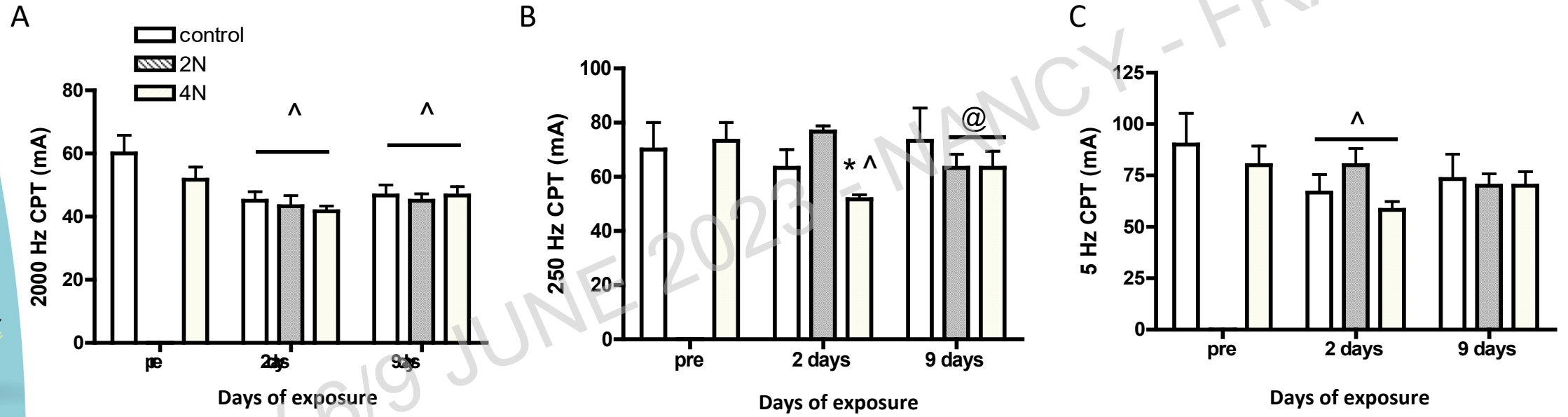
The 0.4-0.2 Hz signal is representative of the arterial pulse. Exposure to vibration reduces tends to reduce the amplitude of the arterial pulse, but the differences are not significant. Repeated exposures result in significant reductions in the width of the 0.4 – 0.2 Hz pulse.

Changes in blood flow may be due to changes in vascular responsiveness to endogenous vasoconstricting (A) and dilating factors (B)



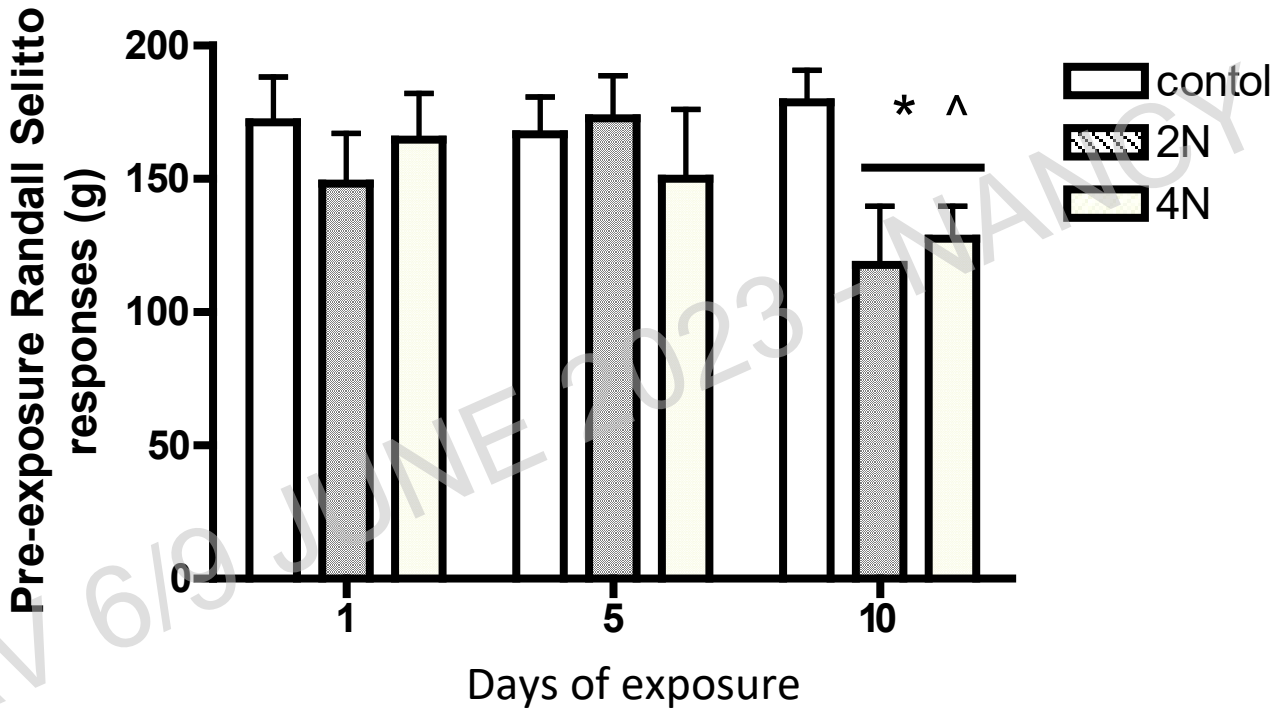


The effects of force on the CPT were primarily seen using the 250 Hz stimulus



Repeated exposure to applied force resulted in a reduction in the 250 Hz threshold in animals exposed to 4N of force for 5 days and in animals exposed to 2N and 4 N of force for 10 days

Exposure to applied force resulted in a reduction in the threshold to pressure applied using the Randall-Selitto aesthesiometer.



Discussion and Conclusions

- Applied force alters blood flow and sensorineural function in our rat tail model.
- Exposure to force increases blood flow over the 10-day exposure.
- The increase in blood flow may be due in part to prolonged changes in sensitivity to ACh-induced re-dilation
- The changes in sensorineural function seen in this study were different than those seen with vibration; Applied force primarily affects the CPT at 2000 Hz (Aβ)
- Examining the combined effects of vibratioin and applied force will reveal a more complete picture on how these factors act together to induce the symptoms of HAVS

Questions?

For more information, contact CDC Kristine Krajnak ksk1@cdc.gov Tel.: 304-285-5964
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348

The findings and conclusions in this report are those of the authors and do not necessarily represent The official position of the Centers for Disease Control and Prevention or of the National Institute for Occupational Safety and Health